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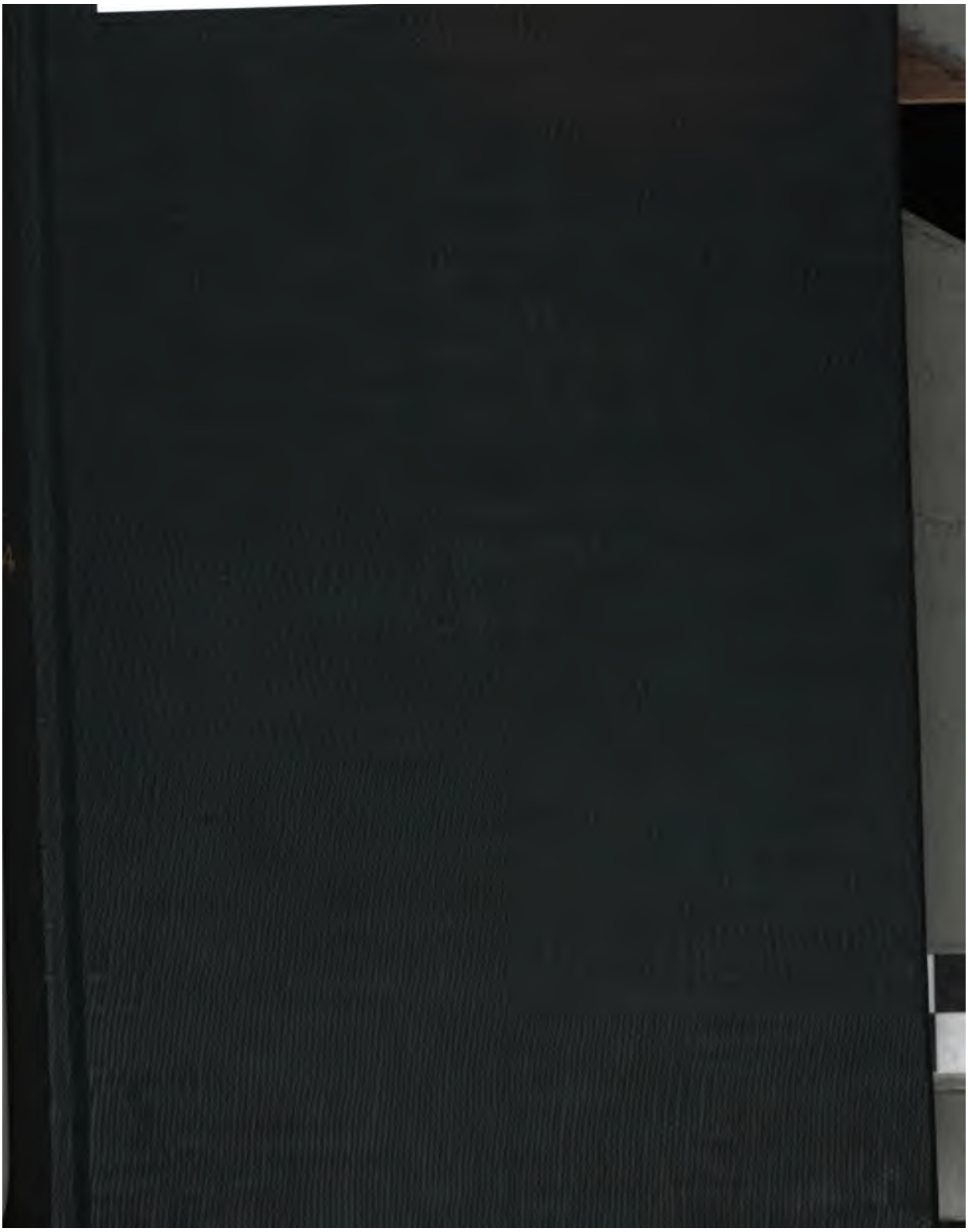
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ANNUAL REPORT

OF

THE BOARD OF REGENTS

OF THE

UNIVERSITY OF MINNESOTA,

TO THE GOVERNOR OF MINNESOTA.

FOR THE FISCAL YEAR ENDING NOVEMBER 30, 1873.

TRANSMITTED TO THE LEGISLATURE OF THE SIXTEENTH ANNUAL SESSION,
1874.

SAINT PAUL:
ST. PAUL PRESS COMPANY.
1874.









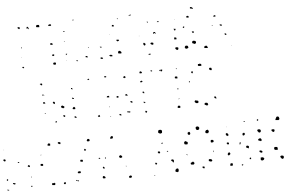


THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, Dec. 22, 1873.

To His Excellency, Hon. Horace Austin,
Governor of Minnesota:

SIR:—In accordance with the requirements of law, I have the honor to hand you herewith the report of the Board of Regents of the University of Minnesota, for the fiscal year ending December 22d, 1873.

I have the honor to be,
Your obedient servant,
J. S. PILLSBURY,
President of the Board of Regents.



The Board of Regents proceeded at once to utilize this appropriation. They advertised for plans for a main building for the University, and also for a building for the Agricultural College. The plans chosen for the latter were presented by Mr. J. W. Bassford, of St. Paul, those for the main building by Messrs. Alden & Long, of Minneapolis. The two buildings are to cost fifty thousand dollars; the agricultural building twelve thousand five hundred, and the principal building thirty-seven thousand five hundred. After advertising the required time for bids for the erection of these buildings it was found that all the proposals overran these amounts. The plans were accordingly cut down and new proposals called for. The reduction and perfecting of the plans and specifications consumed so much time that it was not until the —— day of August that the building committee were able to close a contract with Mr. Michael O'Brien, of St. Paul, being the lowest responsible bidder. The conditions of the contract required the Agricultural building to be enclosed and the foundation of the main building laid before the present winter. By reason of

unaccountable delays, however, the contractor has only laid the foundations of these buildings. The main building is to be 90 feet in length by 75½ feet in extreme breadth, and three stories high, besides basement. It will contain, in addition to recitation rooms, a chapel, library and reading room, President's room and ladies parlor. The agricultural building is to be two stories high and 54 feet in length, by 54 feet in width, with basement, and to have two wings, one for a chemical laboratory, 46 feet in length by 25 feet in breadth, the other for a plant-house of same dimensions. It will also contain recitation rooms for Chemistry, Botany, etc.

LOCATION OF THE BUILDINGS.

After having the buildings now in use carefully examined by experienced architects the Regents decided to continue as far as possible the original design and erect a main building as a continuation of the present section. In this way we secure one central academic building around which may be put up, from time to time, such others for special purposes as cannot properly stand in connection with the central building. The Agricultural College is located upon the University grounds about 25 rods to the south east of the main building. The position was chosen with a view to its being accessible to students from other departments as well as to the experimental farm.

FURNISHING AND HEATING THE BUILDINGS.

These new buildings are to be finished and ready for occupancy at the opening of the next college year in September, 1874. As the appropriation was intended exclusively for the erection of buildings, it becomes necessary to ask the Legislature to set apart a further sum sufficient to enable the Regents to provide the same with the necessary heating apparatus and furniture.

THE FACULTY.

The following changes have been made in the faculty during the past year:

Mr. W. C. Sawyer, a graduate of Harvard University, has been appointed assistant Professor in charge of the German Language and Literature.

Professor N. H. Winchell, graduate of the University of Michigan, has been made Professor of Geology, Zoology and Botany in addition to his duties as State Geologist.

Mr. Dalston P. Strange, a graduate of the Michigan State Agricultural College, has been appointed assistant Professor and placed in charge of the department of Agriculture.

Mr. M. D. Rhame, a graduate of Yale College, has been made assistant Professor in charge of the department of Civil Engineering.

Mr. Samuel F. Peckham, a graduate of Brown University, is appointed Instructor in charge of the department of Chemistry, and Chemist of the Geological Survey.

Mr. Andrew M. Williamson and Mr. Hiram W. Slack were employed as general instructors for a portion of the year.

The General Faculty is at present constituted as follows:

WILLIAM W. FOLWELL, M. A., PRESIDENT,
and Professor of Political Economy.

GABRIEL CAMPBELL, M. A., B. D., VICE PRESIDENT.
and Professor of Mental and Moral Philosophy.

VERSAL J. WALKER, M. A.,
Professor of the Latin Language and Literature.

JABEZ BROOKS, M. A., D. D.,
Professor of the Greek Language and Literature.

ARIS B. DONALDSON, M. A.,
Professor of the English Languge and Literature.

EDWIN J. THOMPSON, M. A.,
Professor of Mathematics and Astronomy.

HELEN SUTHERLAND, M. A.,
Preceptress and Assistant Professor of Latin.

ELI L. HUGGINS, 1st. Lieut. U. S. A.,
Professor of Military Science and Instructor in French.

NEWTON H. WINCHELL, M. A.,
Professor of Geology.

DALSTON P. STRANGE,
Assistant Professor of Agriculture.

MITCHELL D. RHAME, B. A.,
Assistant Professor of Civil Engineering.

WESLEY C. SAWYER, M. A., B. D.,
Assistant Professor of the German Language and Literature.

SAMUEL F. PECKHAM, B. S.,
Instructor of Chemistry.

WALTER E. FIELD,
Superintendent of the Experimental Farm.

NUMBER OF STUDENTS.

The entire enrollment of Students for the Academical year ending June 19th, 1873, is as follows:

Senior Class,	2
Junior Class,	6
First Class, (Sophomore),	10
Second Class, (Freshman),	26
Third Class,	66
Fourth Class,	88
Civil Engineering, (Junior),	3
Latin School,	62
Unclassified,	15
	278

THE FIRST COMMENCEMENT.

The University conferred its first degrees in June last. Two young men had completed the full classical course. The graduating exercises were held in the Academy of Music. The occasion called together a large number of citizens from all parts of the State. An excellent address was given by the Hon. A. S. Welch, President of the Iowa State Agricultural College, and the orations of the graduates were of a character that reflected honor on themselves and their instructors.

After the literary exercises, the Regents, Faculty and Alumni of the University, together with a numerous company of citizens, representing nearly every county in the State, sat down to a hospitable dinner tendered to them, at the Nicollet House, by the citizens of Minneapolis. All seemed to unite in expressions of gratification at the prosperity of the University.

THE LIBRARY.

Rev. Dr. H. P. Tappan, formerly President of the University of Michigan, has recently accepted the long standing proposals of the Board of Regents to purchase his private library. The catalogue of his collection has been carefully examined by the Faculty. It is the opinion of those who know anything of this library that it is one of the finest in the country, and will be an exceedingly valuable addition to the reading matter of the University. The Tappan Library contains twenty-five hundred volumes. This will make the number of volumes in the University Library about ten thousand. Numerous donations of books have also been received from other sources, especially public documents through Senator Ramsey and Representative Dunnell, and from the Smithsonian Institution. A list of these will be found in the accompanying report of President Folwell.

GEOLOGICAL SURVEY.

The Geological Survey has been continued by the State Geologist with good results. His voluminous report will show the value and extent of his investigation in different parts of the State, particularly with reference to the peat deposits, which were carried on in accordance with the law enacted by the last Legislature. A large number of valuable specimens have already been collected by Professor Winchell. The Board hope to be able to provide for the display of these minerals, peats, fossils, etc., etc., so soon as the building now being erected shall have been completed.

AGRICULTURAL COLLEGE.

The superintendent of the experimental farm has during the past year cultivated 35 acres of the arable land under the direction of the Regents committee. A considerable variety of fruit trees has been set out and good crops of wheat, corn and oats secured. The amounts produced have been about the same as last year. The Regents do not think it judicious to expend a large amount on experimental farming until students present themselves who are desirous of instruction in agriculture and who shall be directly benefited by the moneys appropriated to that purpose.

FINANCIAL RESOURCES OF THE UNIVERSITY.

The permanent University Fund consists of lands granted by Congress for the use and support of a State University and the lands granted to the State under the act of July 2d, 1862, donating lands for the benefit of agriculture and mechanic arts.

Whole number of acres granted by Congress, - - - -		202,000
Acres sold to pay debts, - -	14,000	
Acres sold for Permanent Fund, - -	29,950	
Acres unsold, - - -	158,050	
		202,000

PERMANENT FUND.

The permanent fund of the University consists of moneys received from the University lands, sold by the State Land Commissioner.

Whole amount received from sale of lands,		$168,681
Paid for purchase of experimental farm,	8,500	
Actual fund at interest November 30, 1873,	160,181	
		$168,681

EXPERIMENTAL FARM FUND.

Balance on hand as per last report, -	$671 87

UNIVERSITY LAND FUND.

Balance on hand as per last report, -	$39 42
Feb. 12, Cash received on Canfield's note,	275 00
Interest on same, - - -	45 00
Total, - - - -	$359 42

RECEIPTS AND DISBURSEMENTS, CURRENT EXPENSES FROM DEC. 22, 1872, TO DEC. 22, 1873.

Receipts.

Balance on hand as per last report,	$1,633 80
Received from State Treasurer on account of interest on Permanent Fund and Pine Stumpage, -	16,500 00
Received on Regents' orders drawn on State Auditor, - -	9,000 00
	$27,133 80

Disbursements.

For Salary of Faculty, - -	$19,907 50	
For Expense of Regents, -	569 93	
For Printing, - - -	406 83	
For Surveying and Mathematical Instruments, - - -	130 00	
For Library, Books, etc., -	627 43	
For Salary of Farmer, -	600 00	
For Incidental Expenses, - -	2,336 11	
Balance on hand, - -	2,556 00	
		$27,133 80

The report of the Treasurer in detail is appended.

GEOLOGICAL SURVEY.

To Balance on hand as per last report,	$69 08
Received from State Treasurer on account of State Appropriation, -	2,000 00
Received from State Treasurer on account of Appropriation for Apparatus, - - - - -	500 00
Deficiency, - - - -	559 93
	$3,129 01

Disbursements.

For Salary of State Geologist, -	$2,400 00	
For Apparatus, - - - -	416 51	
For Expenses in field, - -	312 50	
		$3,129 01

PRESENT CONDITION OF UNIVERSITY FUND.

Up to the present time the current expenses of the University have been largely met by the moneys received for pine stumpage. This use of the funds is in accordance with a law passed by the Legislature, authorizing the Board of Regents to employ the receipts from sales of pine stumpage to defray the current expenses of the University. The stumpage fund is now nearly exhausted. It was the expectation of the Regents that by this time the sales of the University lands would be more than sufficient to produce a fund whose interest would equal the current expenses of the University. These sales, however, have not been sufficient to secure this result. The great amount of public lands offered to the State by the railroad companies and other corporations has prevented the sale, to any large extent, of the University lands. Such being the case, the Board of Regents find themselves called upon to set forth clearly the amount needed to pay the expenses of the coming year, and to urge upon the Legislature the necessity of making an appropriation adequate to meet the deficit until the sales of lands shall be sufficient, and thus preserve the credit and honor of the institution. It is well to mention that up to this date the Legislature has been called upon to meet no part of the current expenses of the University.

ESTIMATED CURRENT EXPENSES FOR YEAR 1873–74.

The following is an estimate of the amount needed for current expenses for the year commencing Dec. 22, 1873, and ending Dec. 22, 1874:

Disbursements.

For Salaries of Faculty, - - - -	$26,400
For Expenses of Regents, - - -	800

For Insurance, - - - - -	150
For Library, - - - -	800
For Fuel, - - - - -	750
For Incidental Expenses, - - -	1,200
Total, - - - - -	$30,100

Receipts.

Interest on Productive Fund, - -	$11,200	
Amount of Deficit - - -	18,900	
		$30,100

GENERAL PROGRESS.

All the departments of the University are giving evidence of commendable progress. At the beginning of the present year the Latin school was dropped, and by this means the requirements for admission raised one year. The character and general appearance of the students have improved. The growth of the Library and Museum and the completion of the buildings now in process of erection, and other considerations, indicate the rapid development of the State University, and call upon us to stand by this, our highest school of learning, and see that it is made an honorable competitor among the universities of our country.

At a meeting of the Board, at which the foregoing report was agreed to, the following resolutions introduced by Regent Sibley were unanimously adopted:

Resolved, That the Board deeply deplore the recent death of Hon. John Nicols, one of its most efficient and honored members.

Resolved, That the University and the State at large have suffered an almost irreparable loss by the demise of Mr. Nicols, who for many years labored faithfully and earnestly to advance the interests of the State University, and in other

positions proved himself to be an able, honest and industrious officer, and a true friend of Minnesota.

Resolved, That these resolutions be entered on the records of the Board, and that a copy thereof, duly certified by the Secretary, be presented to the family of the lamented deceased.

TREASURER'S REPORT.

JOHN NICOLS, TREASURER, IN ACCOUNT WITH BOARD OF REGENTS OF STATE UNIVERSITY.

1872.	DR.	
Dec. 5,	To balance on hand	$1,633 00
20,	To cash from State Treasurer	2,000 00
1873.		
Jan. 18,	To cash from State Treasurer	2,500 00
Feb. 15,	To cash from State Treasurer	2,000 00
Mch. 4,	To cash from State Treasurer	2,000 00
April 12,	To cash from State Treasurer	2,000 00
29,	To cash from State Treasurer	2,000 00
July 14,	To cash from State Treasurer	2,000 00
		$16,133 00

1872.	CREDIT.	DR.	CR.
Dec. 20,	By cash, President Folwell and faculty, voucher 1		$1,770 00
20,	By cash, J. S. Pillsbury & Co., advances on 18 vouchers, voucher 2		591 86
21,	By cash, Regent Bryant, voucher 3		9 00
30,	By cash, Regent Harwood, voucher 4		19 48
1873.			
Jan. 4,	By cash, Regent Bryant, voucher 5		13 50
	By cash, Treas. salary 1872, voucher 6		300 00
15,	By cash, 14½ c'ds wood and hauling, v. 7.		104 13
18,	By cash, Ramaley, Chaney & Co., vouch. 8.		42 06
22,	By cash, Regent Bryant, voucher 9		4 20
25,	By cash, D. Ramaley, voucher 10		11 25
Feb. 5,	By cash, President Folwell and faculty, voucher 11		1,920 00
7,	By cash, Prof. Sawyer, voucher 12		100 00
Mch. 4,	By cash, President Folwell and faculty, voucher 13		2,020 00
7,	By cash, Chas. Hill, voucher 14		15 00
8,	By cash, Pres. Folwell, travel'g exp. v. 15		165 71
28,	By cash, J. S. Pillsbury & Co., advances on 7 vouchers, voucher 16		138 56
	By cash, Chas. Graves, voucher 17		259 88
April 3,	By cash, President Folwell and faculty, voucher 18		2,020 00

	10,	By cash, Regent Bryant, voucher 19.....		12 00
	12,	By cash, Tribune Print'g Co., voucher 20.		150 40
	30,	By cash, President Folwell and faculty, voucher 21.....		1,920 00
May	2,	By cash, Prof. Thompson, purchase of instruments, voucher 22.....		75 00
	2,	By cash, J. S. Pillsbury & Co., advances on 7 vouchers, voucher 23.....		380 61
	10,	By cash, Prof. Williamson, April salary, voucher 24.....		100 00
	14,	By cash, Dr. C. N. Hewitt, voucher 25....		50 00
	20,	By cash, Stone & Parker, voucher 26.....		60 00
		By cash, G. W. Ford, voucher 27.....		66 38
	31,	By cash, President Folwell and faculty, voucher 28.....		1,920 00
June	2,	By cash, surveying Campus, voucher 29..		58 05
	9,	By cash, Tribune Print'g Co., voucher 30.		18 00
	19,	By cash, President Folwell and faculty, voucher 31.....		1,920 00
July	1,	By cash, Treas. salary 6 mos. voucher 32..		150 00
	2,	By cash, E. M. Herrick, voucher 33.....		50 00
	7,	By cash, Regent Bryant, voucher 34.....		12 00
	10,	By cash, President Folwell and faculty, voucher 35.....		50 00
	15,	By cash, Pres. Folwell, incidental ex., v. 36		190 83
	20,	By cash, Pres. Folwell. house rent, v. 37..		400 00
	21,	By cash, Prof. Campbell, voucher 38.....		400 00
	23,	By cash, Regent Harwood, voucher 39....		24 75
	29,	By cash, Prof. Huggins, voucher 40.....		500 00
		By cash, Press Print'g Co., voucher 41....		6 25
		By cash, Publishing Almanac, voucher 42.		50 00
		By cash, Treas. salary 1 mo., voucher 51..		25 00
Aug.	5,	By cash, Prof. Winchell, voucher 48.....		200 00
	5,	By cash, Pres. Folwell, voucher 49.....		100 00
	8,	By cash, G. P. Randall, voucher 50.....		50 00
	19,	By cash, J. S. Pillsbury & Co., advances on 6 vouchers, voucher 52.....		538 90
		To balance.....	$2,849 80	
			$18,982 30	$18,982 30
		By balance due Treas.....		$2,849 80

GEOLOGICAL SURVEY ACCOUNT.

1872.				
Dec.	31,	To balance on hand.....	$69 08	
1873.				
June	16,	To cash from State Treasurer.....	$2,500 00	
			$2,569 08	

CREDIT.

July	11,	By cash, Prof. Winchell, voucher 43.....		$104 25
		" J. S. Pillsbury, voucher 44.....		301 26
	17,	" Prof. Winchell, voucher 45.....		100 00
	17,	" Prof. Winchell, voucher 46.....		112 50
Aug.	4,	" Prof. Winchell, voucher 47.....		100 00
		By balance.....		1,851 07
			$2,569 08	$2,569 00
		To balance due Geo. Survey account.....	$1,852 07	

EXPERIMENTAL FARM FUND.

1871.		
Dec. 21,	To balance on hand.....	$671 87

LAND SALES FUND.

1871.		
Dec. 20,	To balance on hand.....	39 42
1873.		
Feb. 12,	To cash, Canfield note.....	275 00
	To cash, interest on Canfield note.....	45 00
		$359 42

SUMMARY OF ACCOUNTS.

	TREAS. DR.	
	To balance on Geol. Survey account.....	$1,851 07
	To balance on Experimental Farm.....	671 87
	To balance on Land Sales.....	359 42
		$2,882 36
	TREAS. CR.	
	By balance on General account.....	$2,849 30
		$33 06

PARIS GIBSON, TREASURER, IN ACCOUNT WITH THE REGENTS.

GENERAL FUND FOR CURRENT EXPENSE.

1873.		DR.	CR.
Oct. 25,	To cash received on order drawn by Regents on State Auditor.....	$3,000 00	
Nov. 13,	To cash received from State Treasurer....	2,000 00	
20,	To cash received on order drawn by Regents, on State Auditor.....	4,000 00	
Dec. 4,	To cash received on order drawn by Regents, on State Auditor.....	2,000 00	
	To Prof. Winchell's salary, charged in Treasurer Nicols' report to Current Expense account, now transferred to Geological Survey account.....	1,600 00	
	By balance from Treasurer Nicols' report.		$2,849 30
Sept. 20,	By cash, Farmer's Union, Voucher No. 1..		30 00
27,	" Geo. Hollister, repairs, voucher No. 2.....		24 52
Oct. 10,	By cash, Faculty, in voucher No. 5.....		2,035 00
10,	" Peckham & Field, voucher No. 4.		200 00
16,	" Times, voucher No. 6.....		10 50
28,	" for Chemical Laborat'y, v. No. 10		27 84
Nov. 4,	" Spafford, wood, voucher No. 11..		20 00
6,	" Faculty, voucher No. 12.....		2,035 00
15,	" John Wiley & Son, books, vouch. No. 14.....		22 25

	18,	By cash, Farmer's Union, voucher No. 15..		25 00
Dec.	2,	" A. R. Cass, Janitor, voucher No. 17		47 50
	3,	" Faculty, in voucher No. 18.....		2,110 00
	3,	" Tribune, voucher No. 19.....		36 80
	3,	" Tribune, voucher No. 21.....		16 50
	6,	" Johnson & Smith, voucher No. 22		18 00
	6,	" Chem. Laboratory, vouch. No. 23		33 71
	9,	" Chem. Laboratory, vouch. No. 24		25 60
	9,	" Armstrong, wood, vouch. No. 25.		485 28
	17,	" A. R. Cass, Janitor, v. No. 26....		41 20
			$12,600 00	$10,044 00
		Balance.....		2,556 00
			$12,600 00	$12,600 00

GEOLOGICAL SURVEY ACCOUNT.

		To balance from Treasurer Nicols' report.	$1,851 07	
		By Prof. Winchell's salary transferred.....		$1,600 00
Sept.	20,	By cash for Mackinaw blankets, voucher No. 9.....		11 00
	29,	By cash, Prof. Winchell, voucher No. 27..		200 00
Oct.	10,	" Prof. Winchell, in voucher No. 5.		200 00
Nov.	6,	" Prof. Winchell, in voucher No. 12		200 00
Dec.	3,	" Prof. Winchell, in voucher No. 18		200 00
			$1,851 07	$2,411 00
		To balance.....	559 93	
			$2,411 00	$2,411 00

EXPERIMENTAL FARM FUND.

	To balance from Treasurer Nicols' report.	$671 87

LAND SALES FUND.

	To balance from Treasurer Nicols' report.	$359 42

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, Dec. 1st, 1873.

Hon. J. S. Pillsbury, President of the Board of Regents:

SIR:—I have the honor herewith to transmit the seventh annual report of the condition and progress of the University.

I have the honor to be, sir,

Very respectfully,

Your obedient servant,

WILLIAM W. FOLWELL,

President.

REPORT OF THE

PRESIDENT OF THE UNIVERSITY.

To the Honorable, the Board of Regents:

GENTLEMEN:—The institution opened under your auspices as a preparatory school in October, 1867, celebrated its attainment to college rank by its first commencement, held on the 19th day of June, 1873. The degree of Bachelor of Arts was conferred upon the following persons:

Warren Clarke Eustis, of Hennepin County;
Henry Martyn Williamson, of Nicolet County.

A statement of the aims and organization of the University will furnish a standard by which to estimate its "condition and progress."

The University, by virtue of the organic law, embraces theoretically the following colleges or departments, to wit:

A department of Elementary Instruction;
A College of Science, Literature and the Arts;
A College of Agriculture;
A College of the Mechanic Arts;
A College of Law;
A College of Medicine.

The governing board is further empowered to establish additional departments. Of the above Colleges or Departments the first four have been organized. It is a general principle that each College is a distinct member of the University federation, having its own faculty, buildings and equipment. The Agricultural College, for instance, exists

as an independent department and not as a mere alternative course of studies in a general scientific and literary college. The Department of Elementary Instruction, otherwise known as the "COLLEGIATE DEPARTMENT," however, being temporary in its character, and so long as retained, the common feeder of the higher departments, is placed under the care of the General Faculty, composed of all the professors at large. As regards the other departments now in operation, the general principle stated cannot be fully carried out. The work of all departments is as yet crowded into one uncomfortable and inconvenient building; the professors are, in some instances, obliged to do duty in two or more departments, and the whole instruction is given upon a consolidated programme. This state of things is by no means peculiar to our own State and can be endured for any reasonable time. Most new colleges are forced into the same policy. The chief peculiarity of the organization is the including the work of the Freshman and Sophomore years in the department of Elementary Instruction, with the expectation of ultimately dropping it off to the secondary schools. This feature has received the endorsement of a large number of the best educational thinkers and workers in the country. The process of dropping of this preparatory or secondary work is to be gradual and to be so managed that the University may at all times begin wherever the High Schools leave off. In this way the University will maintain a close and vital articulation with the system of public instruction.

It was on account of this enforced intermingling of functions that the Board of Regents lately adopted, instead of a classified scheme, a schedule of professorships at large. This schedule, here inserted, however far it may be from ideal completeness, is adapted to the present circumstances and prospects.

A SCHEME OF DEPARTMENTS OF INSTRUCTION AT LARGE FOR THE VARIOUS "COLLEGES OR DEPARTMENTS" OF THE UNIVERSITY OF MINNESOTA.

I. Academic or General.	*Associated Subjects.*
1. Mathematics.	
2. Astronomy.	
3. Chemistry.	
4. Physics.	
5. Geology.	Mineralogy.
6. Botany.	
7. Zoology.	
8. Physical Geography.	

9. English Language and Literature.	Rhetoric, Logic, Anglo-Saxon.
10. German Language and Literature.	North European Languages.
11. French Language and Literature.	South European Languages.
12. Latin Language and Literature.	Roman History and Antiquities.
13. Greek Language and Literature.	Greek History and Antiquities.
14. Comparative Philology.	
15. Mental and Moral Philosophy.	History of Philosophy.
16. History.	History of Civilization. Philosophy of History.
17. Social Science.	The Civil Government. International Law.
18. Elocution and Vocal Culture.	Music, Gymnastics.
19. Public Health.	Anatomy and Physiology.
20. Industrial Drawing.	Descriptive Geometry.
21. Fine Arts.	Æsthetics.
II. Professional.	
22. Theory and Practice of Agriculture.	Horticulture and Arboriculture.
23. Civil Engineering.	Architecture.
24. Mechanical Engineering.	Mechanics.
25. Military Science.	
26. Veterinary Science.	Stock Breeding.
27. Education.	
28. Business.	

It being manifestly impracticable to fill all the professorships given in the above list, the following dispositions have been made:

Astronomy has been assigned to the Professor of Mathematics; Botany, Zoology and Physical Geography to the Professor of Geology. French is taught by the Professor of Military Science. The Professor of Mental and Moral Philosophy gives the instruction in Comparative Philology. The department of History has been distributed to various officers, chiefly to the Professor of English Language and Literature. The Professor of Civil Engineering has control also of Mechanical Engineering and Industrial Drawing. The department of Public Health is under the direction of the Secretary of the State Board of Health. Social Science, including Political Economy, has been committed to the President. Elocution is associated with the department of English.

For the following departments and subjects no stated provision can be made: Anglo-Saxon, North European Languages except the Scandinavian, South European Languages except Italian, Philosophy of History, Vocal Culture, Music and Gymnastics, Fine Arts and Æsthetics, Veterinary Science and Stock Breeding, Education, Business. The Executive Committee are authorized to procure such occasional lectures on these subjects as may be feasible.

After all these eliminations there remains for so young an institution a liberal array of professorships; and when the amount of work actually performed by the Faculties is taken into account, it must be admitted that no trifling opportunities are offered to the youth of Minnesota. The following tables exhibit in detail the instruction given in the various departments during the year 1872–73. From these, some opinion can be formed as to what progress has been made toward the objects aimed at in the charter.

THE WORK OF THE YEAR.

The following is a statement in detail of the kinds and amounts of work performed in the various departments at large:

1. DEPARTMENT OF MATHEMATICS AND ASTRONOMY.

Subject.	Class.	No. Exercises.	No. Students.
Higher Arithmetic	Lat. Sch.	65	52
Algebra	Lat. Sch.	92	43
Higher Algebra	IV. & II.	92	112
Plane Geometry	III.	61	30
Solid Geometry	II.	30	32
Plane Trigonometry	II.	31	33
Spherical Trigonometry	II.	20	18
Surveying	II.	12	18
Analytical Geometry	I.	62	11
Differential Calculus	Junior.	45	4
Integral Calculus	Junior.	25	3
Modern Geometry	Junior.	20	3
Descriptive Astronomy	I.	30	10
Practical Astronomy	Senior.	35	2

2. DEPARTMENT OF CHEMISTRY AND PHYSICS.

Subject.	Class.	No. Exercises.	No. Students.
General Chemistry	II.	61	35
General Chemistry, continued	II. Sci.	61	15
Analytical Chemistry	Junior.	60	3
Natural Philosophy	IV. Sci.	130	55
Mechanical Physics	I.	65	10
Chemical Physics	I. Sci.	61	

3. DEPARTMENT OF NATURAL SCIENCES.

Subject.	Class.	No. Exercises.	No. Students.
Elements of Geology	III. Sci.	32	21
Advanced Course in Geology	Junior.	65	5
Structural Botany	III. Sci.	33	24
Systematic Botany	III. Sci.	32	15
Elements of Zoology	I. Sci.	32	11
Physical Geography	III. Sci.	61	16

4. DEPARTMENT OF ENGLISH LANGUAGE AND LITERATURE.

Subject.	Class.	No. Exercises.	No. Students.
Hart's Composition	IV.	61	70
Rhetoric	I.	28	6
Logic	I.	60	8
English Literature	Junior.	60	4
Rhetorical Exercises, Oral	4 upper.	54	34
Rhetorical Exercises, Written	4 upper.	65	34
Rhetorical Exercises, Rehearsals	4 upper.	300	34
English Grammar	Lat. Sch.	60	55
English Analysis	Lat. Sch.	28	49

5. DEPARTMENT OF GERMAN LANGUAGE AND LITERATURE.

Subject.	Class.	No. Exercises.	No. Students.
Grammar and Reader	Jun. etc.	65	55
Grammar and Reader Continued	Jun. etc.	65	26
Grammar and Reader	IV. etc.	65	30
Grammar and Reader	IV. etc.	32	23
Iphigenie auf Tauris	Sen. etc.	65	33
Evans' Abriss	Sen. etc.	65	28
Jungfrau von Orleans	Jun. etc.	32	14
	III. etc.	32	18

6. DEPARTMENT OF FRENCH LANGUAGE AND LITERATURE.

Subject.	Class.	No. Exercises.	No. Students.
Fasquelle's Method, &c	II.Sc.&Lt.	190	18

7. DEPARTMENT OF LATIN LANGUAGE AND LITERATURE.

Subject.	Class.	No. Exercises.	No. Students.
Grammar and Reader	Lat. Sch.	190	68
Cæsar's Commentaries	IV.	125	50
Cicero's Orations	III.	129	29
Virgil's Æneid	III.	90	31
Livy, History of Rome	II.	75	12
Horace, Odes, Satires and Epistles	I.	75	7
Plautus' Captives	Senior.	75	2
Juvenal, Satires	Junior.	35	1
Tacitus, Germania and Agricola	Junior.	75	1
Latin Compositions	3 Lower.		
Roman History and Geography	II.	35	12
Roman Antiquities	I.	35	7
Roman Literature, Lectures	Junior.	8	1

8. DEPARTMENT OF GREEK LANGUAGE AND LITERATURE.

Subject.	Class.	No. Exercises.	No. Students.
Grammar and Reader	IV.	170	19
Xenephon, Anabasis	III.	186	15
Herodotus, History	III.	32	12
Homer, Iliad	II.	180	10
Grecian Antiquities	II.	30	10
Grecian History and Geography,	II.	10	10
Essays	II.	5	10
Demosthenes, Philippics	I.	63	5
Aristophanes' Clouds	I.	33	5
History and Geography	I.	15	5
Plato	Junior.	63	1
Aristotle	Junior.	17	1
Essays	Junior.	3	1
History	Junior.	5	1
Greek Literature, Lectures	Senior.	12	2
Greek Literature, Reviews	Senior.	12	2

9. DEPARTMENT OF COMPARATIVE PHILOLOGY.

Subject.	Class.	No. Exercises.	No. Students.
Science of Language, Lectures	Senior.	26	2
Science of Language, Lectures	Juniors.	26	6

10. DEPARTMENT OF MENTAL AND MORAL PHILOSOPHY.

Subject.	Class.	No. Exercises.	No. Students.
History of Philosophy..... }	Senior.	68	3
Ontology }			
Psychology.....	Junior.	63	4

11. DEPARTMENT OF HISTORY.

Subject.	Class.	No. Exercises.	No. Students.
United States History.....	Lat. Sch.	60	62
Outlines of General History.....	II.	60	40

12. DEPARTMENT OF SOCIAL SCIENCE.

Subject.	Class.	No. Exercises.	No. Students.
Political economy.....	Senior.	60	3
Story on the Constitution.....	Senior.	35	3
International Law, Woolsey.....	Senior.	25	3

13. DEPARTMENT OF ELOCUTION.

See English Language and Literature.

14. DEPARTMENT OF PUBLIC HEALTH.

Subject.	Class.	No. Exercises.	No. Students.
Physiology	II &IV.Sc.	32	48
Lectures.....	all.	12	all

15. DEPARTMENT OF INDUSTRIAL DRAWING.

Subject.	Class.	No. Exercises.	No. Students.
Use of Instruments and Materials.....	III.	65	31
Plane Problems.....	II Sci.	65	16
Elementary Projections.....	II.	65	18
Descriptive Geometry.....	I.	65	4
Linear Perspective.....	I.	30	3

16. DEPARTMENT OF CIVIL ENGINEERING.

Subject.	Class.	No. Exercises.	No. Students.
Farm Surveying and use of Instruments.	Junior.	30	4
Leveling and use of Instruments.....	Junior.	35	4
Topographical Drawing.....	Junior.	65	4
Analytical Mechanics.....	Junior.	50	1
Triangular Surveying.....	Junior.	30	1

17. DEPARTMENT OF MILITARY SCIENCE.

Subject.	Class.	No. Exercises.	No. Students.
Squad, Company and Battalion Drill...	all male.	28	107

18. DEPARTMENT OF AGRICULTURE.

In regard to Agriculture, it must be noted that all the scientific studies, nearly all the mathematics, and many other branches, are directly related both to Agriculture and the Mechanic Arts, and that consequently the Institution has been at all times fulfilling both the letter and the spirit of the Act of Congress which donated public lands to endow the "National Schools of Science." It is a grave mistake to regard these institutions as exclusively "Agricultural Colleges." The national bounty was granted to endow "colleges" in which should be taught "such branches as are *related to* Agriculture *and* the Mechanic Arts, without excluding *other* classical aud scientific studies and including military tactics,

for the benefit"—not of farmers exclusively,—but "of the *industrial classes* in the *several* pursuits and professions of life." The University is, therefore, constantly engaged in teaching the required studies to the persons entitled to receive instruction, for the purposes prescribed.

If no special technical work has been done in Agriculture, it is simply and solely for the reason that there has been no demand for it. So far as I am aware, not a single young man has come here desiring to learn the Science of Farming, in order to practice it. A large number of students desire instruction in Civil Engineering, Industrial Drawing and the related studies, with a view to professional practice. A regular junior class was taught during the whole year in the College of Mechanic Arts. I expect this College to take the lead of the Agricultural College for some years, although the completion of the special building for the latter may change the present aspect. The time will, however, come soon, and sooner than will be wished, when the Agricultural College, as yet not indispensable in the new States, will become so. Our soils now being robbed to feed the millions of other regions, will too soon need the aid of science to enable them to yield paying returns. Meantime, let the precious endowments be wisely husbanded. The professor of Agriculture is excellently employed in teaching the sciences related to his department.

REMARKS.

The course of lectures upon "Public Health" was delivered weekly in the Assembly Hall, during the winter term. They were numerously attended not only by the members of the University but by others. The subjects were:

1. Public Health as a condition of national education and culture, with an historical review.
2. The Atmosphere, its relations to man.
3. Water, its sources, composition and relations to man; also methods of storing, purifying and distributing water.
4. The Soil, its relations to public health, with the uses and methods of drainage.
5. The House, as the physical centre of the home; the relations of the family to public health.
6. Light in the house.
7. Heating and ventilation.
8. The use and abuse of food.
9. Brain work.

10. The prevention of disease.
11. Diseases resulting from accidents and injuries.
12. General resume of the course, with a statement of the objects and claims of the department.

If I do not mistake, the Univerity of Minnesota may announce herself as the first American College to offer systematic instruction to the whole body of students on the subject of public health. We have scores of institutions devoted to instructing a class of professional persons in the science of healing others; much has been done in many quarters in teaching individuals how to preserve their health; but I know of no previous instance in which the attempt has been made to inform a whole body of under-graduates, as to what families, neighborhoods, municipalities and states are bound to do, to promote the "public health." It is proper to add that the course was without expense to the Board, except a small sum for the traveling expenses of the professor.

To the officer in charge of the department of Civil Engineering, Mr. M. D. Rhame, and to the gentlemen under his instruction, the University is indebted for a minute and accurate topographical survey of the Campus.

The professor of Military Science formed at the beginning of the third term a corps of volunteers desiring extra instruction, which he has already brought into a commendable condition of skill and discipline.

STUDENTS.

The following table shows the attendance and classification for the year, (1872-3.)

Department.	Class.	Gentlemen.	Ladies.	Total.
Coll. Sci. Lit. and Arts.....	Senior.	2		2
	Junior.	6		6
College of Mech. Arts.....	Senior.			
	Junior.	3		3
Collegiate Department.....	First.	6	4	10
	Second.	21	5	26—47
	Third.	51	15	66
	Fourth.	67	21	88
	Special.	10	5	15
Latin School.....		40	22	62
Total Enrollment.....		206	72	278

The total enrollment exceeds the total of actual attendance by seventeen.

Two hundred and fifty-five were registered as residents of Minnesota; twenty-one, of other States and provinces; two, unknown.

The following States and provinces were represented: Illinois, Indiana, Iowa, Maine, Michigan, Missouri, Montana, New York, Ohio, Wisconsin, Ontario and Nova Scotia.

The attendance from the State was distributed by counties as follows: Anoka, 1; Blue Earth, 4; Brown, 1; Dakota, 14; Dodge, 1; Douglas, 1; Fillmore, 25; Freeborn, 4; Goodhue, 4; Hennepin East, 72; Hennepin West, 62; Houston, 1; Kandiyohi, 2; LeSueur, 6; Meeker, 3; Mille Lacs, 4; Mower, 5; Nicollet, 2; Olmsted, 3; Ramsey, 8; St. Louis, 3; Scott, 1; Stearns, 4; Steele, 2; Wabashaw, 3; Washington, 8; Winona, 4; Wright, 6.

In regard to the attendance from Hennepin county, it is proper to remark that of the total, 32 students were from the country, and 23 sons or daughters of transient city residents. There remain but 77 to be accredited to the University town.

The following items will not be without interest. 101 students depended wholly or partly upon their own earnings for support, and 57 are believed to have earned a maintenance.

The average expenses of 20 students, boarding in a club for a year, as derived from confidential statements, are as follows:

Room rent,	$4 00
Board, 38 weeks,	76 18
Washing,	13 00
Fuel,	8 20
Lights,	2 43
Books and stationery,	16 84
Incidentals,	6 00
Society expenses,	1 88
Travel,	13 69
Clothing,	59 14
Average of total expenses,	$198 89

107 students have been teachers of common schools. My opinion is, that the proportion is below that of previous years.

ADMISSION.

The whole number of applicants for admission was 140; 35 failed to pass the examinations, being just 25 per cent.; 33 were admitted with conditions. Leaving out of account the higher branches, the examinations in the elementary studies show a slight improvement over those of the previous year. The per cent. of merit was as follows: Reading, 77; Writing, 77; Spelling, 71; Arithmetic, 70; Geography, 63; English Grammar, 79.

I desire in this place to call attention to the dropping of the Latin School at the close of the year. In consequence of this, the following studies will not hereafter be taught, viz.: Higher Arithmetic, English Analysis, United States History and Latin Grammar. Applicants for admission at the beginning of the year will accordingly be examined in these studies, in addition to those named in the foregoing paragraph.

It is proper also to give notice that the requisites for admission will be still further increased from and after the close of the year 1874–5, at which time, by virtue of a resolution of the Board of Regents, another year's work will be cast off. This includes the following studies, viz.: Elementary Algebra, Natural Philosophy, English Composition, Physiology, Greek Grammar, Cæsar's Commentaries and Cicero. Applicants for admission will, after the time named, be examined in these branches according to their courses of study. Classical students only, will be required to pass on both Greek and Latin. No time has yet been set for the relinquishment of the remaining preparatory work, nor for that of the classes commonly called Freshman and Sophomore, as contemplated in the plan of organization.

BUILDINGS.

I congratulate myself that it is not necessary to represent in this report the need of additional buildings. The extension of the main building and the special structure for the Agricultural College which you are now putting under contract will answer most of the immediate necessities and will immensely increase the power of the institution. Still three departments, those of Science, Literature and the Arts, the College of Mechanic Arts, and the Collegiate Department will be assembled under the same roof. The College of Mechanic Arts or Engineering Department will at no distant

day require its separate buiding in which its special work may be carried on. I do not deem it advisable to enter upon a description of the new buildings in this report. It will be better to describe them as they actually stand when completed. Ample as the time may now seem, I am convinced that there is great danger that they may not be ready for occupancy by the opening of the year 1873–4. The contractor ought therefore to be strictly bound to punctuality as well as to substantial and tasteful performance of the work. An early day should be fixed upon for determining the repairs and modifications necessary to unite and harmonize the present structure with the new addition. The estimates for heating apparatus need to be made at once.

THE CAMPUS.

The location of the Agricultural College building has made it necessary to assume a provisional disposition of these grounds, which has been done under the professional advice of Messrs. Cleveland and French, landscape architects. The topographical map made from a careful survey by students of the Engineering classes under the direction of Professor Rhame has been very useful. In the present circumstances when so many things are needed for the proper execution of our work, I could not advise any large expenditure on landscape decorations. It will, however, be indispensable, so soon as the plans can be settled upon, to lay out and grade some approaches to the buildings. I have expended a small amount from the incidental fund in keeping the grounds clear of undergrowth and rubbish. Such are their natural advantages that without any expense or artificial improvements, they are considered very attractive.

THE EXPERIMENTAL FARM.

In regard to this part of the property I have no information not already accessible to you. I take occasion to remark that the separation of the farm by a wide stretch of unfenced territory difficult to traverse by reason of drifting sand, renders it practically impossible to employ student labor. Many young men would be glad to work on the farm if they were not obliged to consume time and strength in getting to and from it. If any kind of manual labor system is at any time to be introduced into the Agricultural

College the farm and the College must be approximated, or other experimental grounds provided which shall be more accessible:

THE LIBRARY.

Important donations have been made to the Library since the last report. The annual appropriation of $500 had not been expended at the close of the academic year. The printed catalogue of authors has been the occasion of a largely increased use of the Library by students. This will doubtless be still more marked when the index of subjects, now in preparation, shall be published. The liberal policy of allowing students to borrow books for home use, has not resulted unfavorably, and I would recommend its continuance. Books of reference, however, maps, and all rare and costly work are excepted and accordingly "starred" in the catalogue. Attention is respectfully called to the appended tables showing the donations, the number and kinds of books borrowed by students, and the list of periodicals supplied to the reading room, etc. The usual appropriation is asked for the reading room and for binding. A stated salary ought also to be voted for the Assistant Librarian, whose services have become indispensable.

It is important that the Board understand that the suitable storage of the Library in the new building, even without hoped-for additions, will involve considerable expense. The books now stand on temporary open shelves, in a room selected because not otherwise available. In the new rooms there should be closed presses, with wire screen doors, which leave the books clearly in view while preventing their disarrangement. I would respectfully renew my recommendation that so soon as possible the standing annual appropriation for the Library be fixed at a sum not less than the salary of a professor.

APPARATUS.

With the exception of some indispensable supplies to the chemical laboratory, no additions were made during the year. Impossible as it is to display and to even conveniently use what we have, the Faculty have refrained from asking for new apparatus. The attention of the Board is called to the statements of professors in relation to the wants of their various departments. I do not think any of the

claims are excessive. The remarks made above apply also to the Natural History and other collections, in regard to which the Curator's report should be referred to.

THE GEOLOGICAL SURVEY.

The report of Professor Winchell upon the progress of the survey is herewith transmitted. I think the University may congratulate herself upon the good fortune of having the great enterprise entrusted to her, and upon the progress which has been made in so short a time. While leading scientific journals in the East are laboring to demonstrate the propriety of States employing their Universities in such enterprises, this young institution on the frontier, is already actively engaged in the survey. Our students have and improve the opportunity of assisting in actual scientific work. The preliminary report published last winter has been called for from many quarters. The edition being exhausted, I deem it important that action be taken for issuing a new one.

I have already represented to the board the importance of employing a Chemical Professor, competent to carry on the chemical investigations of the survey.

No great length of time should elapse before the botanical and zoological, including the entomological, investigations are systematically undertaken.

In regard to the topographical operations I have the pleasure of acknowledging the friendly assistance, both promised and actual, of Maj. Gen. A. A. Humphreys, chief of engineers, United States Army, and the officers of this Lake survey, under his direction. The following documents have been received:

Tracings of the surveys of the Mississippi River from above the Falls of St. Anthony to the Iowa line.

A map of Duluth harbor and vicinity.

A map of Dakota Territory.

The results of measurements to determine the latitude and longitude of the University made under the orders of Brig. Gen. Comstock, chief of the Lake survey, will probably be received before this report is printed.

The results of the operations of the joint commission to locate the Northern Boundary will by the courtesy of Major Wm. Twining will become accessible as soon as the reductions shall have been finally reported.

I trust that no obstacle may be interposed to the ultimate

completion of a map of the State as complete and reliable as the means of science can render it. Many States are losing taxes enough to more than pay the interest on the cost of a correct map. I trust that the general Government will consent to expend a reasonable sum in covering the whole settled portion of the country with a network of astronomical stations. These would form the basis of further trigonometrical operations at the expense of states, counties and municipalities.

THE FUTURE.

The present appears to me to be one of those epochs, when those charged with the guardianship of the University, should, after a careful review of the present situation and resources, take grave and earnest counsel together in regard to the future. The institution is no longer a preparatory school. The extension of our buildings will give us the external apperance of a College. The appropriation of a liberal sum of money for these buildings may be taken as the announcement on the part of the State that she means to have a University and to have it here. This resolution has been taken none too soon. Further delay would have justified the establishment of other institutions, as rendered necessary by the negligenceof the State. As it is, we must expect competition, since there is no law—and rightly so—against the foundation of private schools along side the public ones. It were a shame, however, if the State should ever permit competition to amount to rivalry. Enjoying no monopoly in the business of superior education the State University must abide by the rule of the market. She must offer better instruction, more thorough discipline,

OFFICE OF U. S. LAKE SURVEY,
DETROIT, Sept. 10, 1873.

Pres. W. W. Folwell, University of Minnesota, St. Anthony Falls:

DEAR SIR: * * * * I send the results of a preliminary reduction giving for latitude of the cupola of the University building 44 degrees 58 minutes, 39.22 seconds, and for longitude 93 degrees 14 minutes 8.6 seconds west from Greenwich.

This longitude was obtained as follows:

	Deg.	*Min.*	*Sec.*
Naval observatory, Washington, D. C. west from Greenwich.....	77	03	00.
Detroit—observatory west from Washington, D. C.....	5	59	59.85
S. E. corner Custom House, St. Paul, west from Detroit.....	10	02	32.25
Cupola of University west from St. Paul Custom House.....		8	36.50
Cupola of University west from Greenwich.....	93	14	08.60

Should the final reduction change the above values you will be notified of the fact.

Very respectfully,
Your obedient servant,
C. B. COMSTOCK,
Maj. of Engrs. and Brevet Brig. Gen.

ampler opportunities for culture than others, or see the youth of Minnesota passing by her doors. The following quotation states the matter at least vigorously: "The same agencies that are so effective in other departments of progress, need to be taken into consideration in building colleges * * * The best equipped railroad carries the most passengers and freight. * * * The college furnished with a corps of trained teachers; the college * * * * enjoying the prestige of new discoveries; the college whose very atmosphere is literary, and whose name is synonymous with the most recent scientific researches; *that* is the college to which students will always throng and which will lead the intellectual life of the State."

If the people do not intelligently and resolutely purpose to have their State University take the position thus indicated, the sooner they abandon the whole field of higher education to private agencies the better. The conclusive argument for State Universities is that the people may thereby provide their children with better opportunities than the colleges of numerous competing religious communities can possibly offer. It is almost a crime for a State to add to the number of small and ill-appointed colleges. This is not said in any spirit of complaint or petulance or disappointment, but as a prelude to this clear fact, which had better be faced now, that if the State of Minnesota wishes to have a University worthy of the name, and of her name, she must, within a few years, put into it a great deal of money. A little money, and even large sums thrown in at wide and uncertain intervals, would be worse than wasted, because a starveling concern, plac arded with the magnificent title of "University of the State of Minnesota," would be a disgrace to the Commonwealth, and a stumbling-block in the way of more enterprising institutions. This question, then, is imminent and vital: From what sources can a large and steadily increasing revenue be drawn? To say nothing of building, furniture, libraries and apparatus, the University needs to-day the sure prospect of an annual income of $30,000 for the next three years, and thereafter for the remainder of the decade, of $50,000. After 1880 the annual income ought to be raised to $100,000 as rapidly as possible. Meantime such dispositions should be made as will ensure, before the middle of the next century, a productive capital of not less than five millions of dollars. So much would ensure the permanence

of an institution of high rank; further endowments might be left to coming generations. The sums named will seem large to those who have not informed themselves as to the expenses of Universities. Harvard University expends annually a sum about equal to the interest on $5,000,000 at six per cent. The estimated expenses of Michigan University, for the current year, are $106,000.

In connection with this subject I will, with your indulgence submit the following suggestions:

(1.) That the whole remainder of University lands not yet located be located in the pine districts. If I am correctly informed 400,000 acres of pine lands are held in this and an adjoining State for the benefit of an Eastern Institution. It ought to be possible for the Board to secure the location of a few thousand acres in our own State for the endowment of our own University.

(2.) In order that this may be accomplished, and that the whole business may be in the hands of those best informed and most nearly concerned, I do not hesitate to recommend that the Legislature do immediately entrust the Board of Regents with the custody and disposition of all the University lands. The chief business of Boards of Regents or Trustees is the safe keeping and judicious investment of the property and endowments. If, however, they are to be reduced to the position of mere disbursing commissions, it were as well to dispense with them altogether, leaving the Faculty to fill vacancies in their number and to draw their salaries directly from the State Treasury.

(3.) The State has in her possession certain public lands which might, in my opinion, be better appropriated for the education of the people than divided among corporations, whether formed for transportation or for other purposes. In no way can the real wealth and prosperity of the State be so effectually increased and insured as by judicious expenditures for education.

(4.) The State of Minnesota is one of a number having just claims against the General Government for an equalization of the land grant of 1862 for the benefit of the "National Schools of Science." That grant, it will be remembered, was apportioned to the States then represented in Congress at the rate of 30,000 acres to each Senator and Representative. New York received 990,000 acres; Minnesota, a State nearly double in area, 120,000 acres. Each succeeding census will magnify the injustice of the allotment. Eleven States and Territories have as yet received

nothing under the act. Various attempts have been made to secure from Congress the much needed redress. The so-called "Morrill Bill" which failed to become a law last winter, because its friends consented to let it go to a conference committee near the close of the session, had this for its main object. Instead, however, of proceeding directly to right the old wrong, it proposed by a new distribution in equal amounts to the States at once to silence clamors for justice, and to disarm the opposition of those already in possession of the lion's share. The passage of the Morrill Bill, while it would have given much immediate relief and satisfaction, would in my opinion, have proved a mere placebo. The old injustice would not have been remedied. The sentiment of justice is strong in the American people. Should the General Government, impelled by them, at length resolve to remedy this unequal distribution, our State would receive a handsome addition to its educational endowments. I would respectfully suggest that the Board request the Governor and Legislature to demand of Congress an immediate investigation of this subject.

(5.) Pending the accumulation of productive funds from the sales of the University lands, the example of the State of Michigan might be followed in assigning to the support of the University a small proportion of the tax for educational purposes.

IMPENDING NEEDS.

It would serve no practical purpose to discuss at this time the remote and ultimate demands of the University which may grow up from the present beginnings. I confine myself to a statement of such as seem to require immediate or early attention.

I place first among our needs, a competent instructor in Elocution and Vocal Culture. The instruction in these subjects has been cheerfully given by the Professor of Rhetoric and English Literature, but who can not longer carry it on without injury to his own department. If the person to be employed should be competent to assist in teaching History and in Rhetoric, it would be possible to delay the appointment of other officers. Provision, however, should be made for filling the chair of History at no distant day.

With the completion of the new buildings, while our literary and classical work will be none the less, will come a large increase and development of our general scientific

work. Apparatus of various sorts, in large amounts, will be needed. The time has gone by when the teacher of science can sit in his easy chair and hear his pupils relate what certain text-books state as to the alleged behavior of substances and forces. He has got to teach the thing itself, on the spot, by means of actual materials and appropriate apparatus. If we do not equip our scientific departments with the proper means of illustration, we must not complain if our young men emigrate to Troy, New Haven, Boston or Hoboken, to study general and applied science.

The Chemical Laboratory will need a complete outfit of furniture and a large addition of apparatus and supplies.

The Physical Laboratory will need almost everything. The Library must, if possible, be supplied with scientific and mathematical books, of which the present stock is very meagre. The Engineering department ought to be provided with the indispensable machines, instruments, models, and with steam or other motive power. The Museum will need a large expenditure for cases to contain specimens. What demands the agricultural college will, after receiving its outfit, make for instruction and means of instruction cannot now be foreseen. The plan for a course of technical instruction to be given to young farmers during the winter months, which I have heretofore had the honor to suggest, I still believe feasible, and to be the best way to begin the proper professional work in that College. I trust it may be possible to assemble, after the close of the working season, a class of young men, either already engaged in farming or about to enter upon that profession, to whom such instruction may be given during the winter, as they will be able to put to practical use on returning to their farms in the spring. It was in a manner similar to this that our American law and medical schools began their work, and still carry it on.

The plant house attached to the College will doubtless be stocked, according to agreement, by members of the State Horticultural Society. A gardner will have to be employed to attend it. If experiments in stock breeding or in fruit and forest culture are to be undertaken, funds in considerable amounts will be needed.

The Department of Military Science needs a drill hall and a parade ground. The University year begins in September and ends in June. No outdoor drills can be had after October 31st nor before May 1st. The Vacation lasts from June 20th to September 10th. There remain thus less than three months (say 50 working days,) during which the

department can be in actual operation. A drill hall is therefore indispensable, if there is any real desire to have the department succeed. The University of Wisconsin has provided a very comfortable building at a cost of $3,000. Two boys' schools in this State have drill halls of sufficient dimensions. It is simple justice to say that, under all existing disadvantages, that such has been the zeal of our young men and the diligence of their instructor, that we could furnish to-day 75 gentlemen competent to take command of volunteer companies. I am still in favor of the organization of the Department of Military Science as a separate College.

ASTRONOMICAL OBSERVATIONS.

I deem it important that the department of Astronomy be provided with a working observatory. Fortunately, such have been the improvements in instrument-making and in the methods of observing, that no enormous expense will be needed. I have the estimates of two practical astronomers, according to which $7,500 will buy the essential instruments and erect a building to shelter them. Three objects are to be attained in such an enterprise: (1) The instruction of our students; (2) the stimulation of interest in science generally within the University; (3) contributions to the stock of astronomical knowledge. One Western University has already placed both the Old World and the New under obligations for brilliant discoveries.

NEW DEPARTMENTS.

While I do not regard it indispensable, nor even desirable, that departments of Law and Medicine be immediately opened in the University, it is still important that they be taken into account in planning for the future. It is a consideration which largely compensates for enforced delay that much needed reforms in the organization and management of such schools are in progress. Three medical colleges, at least, now require an examination on elementary studies, as a requisite for admission, and the authorities of two law schools are seriously proposing the same thing. For my own part I would say, better never open such departments here than to swell the number of existing low grade, mercenary professional schools. Our people, furthermore, are more concerned in learning how all may keep

well and out of litigation than in gratuitously instructing a few persons how to cure diseases and argue in the courts.

NORMAL WORK.

A very large percentage of our students are teachers and many expect to devote themselves to that work. While I am of the opinion that after some years it will be desirable to open in the University, as the proper place, a Normal Department for training teachers of high schools. I do not think such an undertaking to be now feasible. I would, however, recommend, and that earnestly, that a Normal professor be appointed at an early date whose duty shall be to give general instruction in methods of teaching higher branches. Under the new law requiring County Superintendents to have first grade certificates, several persons have applied for instruction and one was actually instructed by a member of the faculty during the vacation. The officer above referred to, might be useful in instructing such candidates.

NON-RESIDENT PROFESSORSHIPS.

The University has done but little in providing lectures. Means have been wanting; the assembly hall is not attractive nor convenient; and the University building has been difficult of access. The completion of the lower bridge now building across the Mississippi river, and that of the contemplated street railway will remedy the last named diffiulty. The new assembly hall will be a commodious and cheerful audience room. The question of means remains for the consideration of the Board. So soon as these can be provided it will be very desirable to offer our students and the public a liberal assortment of lectures by non-resident professors of established reputation and approved competency. The experiment of last winter in the lectures of Dr. Charles N. Hewitt on Public Health affords much encouragement to increase this kind of opportunities. I have already had the honor to recommend the holding of Agricultural Institutes in different parts of the State, at which lectures should be delivered by distinguished professional persons employed for the purpose.

POST-GRADUATE COURSES.

The new catalogue ought not to be issued without con-

taining the outline of one or more courses of post-graduate studies. The General Faculty have already been requested to furnish a draft embracing their suggestions.

LODGINGS.

The question of lodgings, which has at all times presented its difficulties, is at length solving itself. The set of lodging houses projected by a member of the Board, will be completed by the beginning of the year 1873-4, and will furnish shelter to about fifty young men. Other persons have rooms to let at reasonable rates. Those students who are able to pay for regular boarding, have no difficulty in finding accommodations. There are two occasions upon which the interference of the Board may be necessary—the first to provide additional lodgings for young men who need to board in clubs; the second, to secure suitable rooms for young ladies sent from distant parts of the State. A Ladies' Boarding Hall is an immediate necessity. No large sum of money need be expended at once. $10,000 would, in my opinion, put up a wood en building of sufficient capacity for present needs and of b ecoming appearance. Dormitory buildings, like hospitals, had better be rebuilt at intervals of a few years. A young ladies' hall, conducted on the "South Hadley" plan, would put the advantages of the University within the reach of a great number of young women, desiring to enjoy them, and who are now practically debarred from them.

Such are the chief demands now imepnding upon your honorable body, to whose wisdom I confidently refer them. It will, perhaps, be said that we are making undue requisitions upon the public purse. To this there are two answers; The first, that we really demand nothing, but merely apprise the people that they cannot have a University without money in large amounts and at proper times; the second, that if the generous policy be now adopted, the institution will receive other than public benefactions. It has become almost a fashion for wealthy friends of education to make large donations to institutions of established reputations and assured permanence. Let it become apparent that the people are resolved to endow and sustain a "genuine University," officered and equipped in the most liberal manner, and our prosperous capitalists will at length vie with one another in their contributions.

There are two subjects to which I especially desire the

early attention of the Honorable Board, which, owing to the length of this report, I refrain from discussing. They are, (1,) the matter of Preparatory schools; (2,) that of Latin as a requisite for admission to all regular courses. I content myself with respectfully referring the Board to my annual report to the State Superintendent for the year (1872–3,) in which these subjects are brought forward.

Your attention is called to the accompanying reports of my respected colleagues, which, of themselves sufficiently attest the industry and fidelity of those officers.

All of which is respectfully submitted,

WILLIAM W. FOLWELL.

APPENDIX A.

AN ACCOUNT OF THE FIRST COMMENCEMENT OF THE UNIVERSITY, CONDENSED FROM THE MINNEAPOLIS DAILY TRIBUNE OF JUNE 20, 1873.

Although it is now twenty-two years since the charter of the University was granted, the institution was only first opened as a preparatory school in 1867. Yesterday she celebrated her first commencement. She now has her alumni, and consequently is entitled to a place among the colleges and universities of the land. Her past has been stormy, and attended with many hardships; her future is full of promise and hope.

A very large audience of ladies and gentlemen assembled in the Academy of Music, Friday, to witness the Commencement exercises. On the stage were Governor Austin, Ex-Governor Sibley, Ex-Governor Marshall, the Regents of the University, the Faculty, the graduating class and the University choir. The splendid regimental band of twenty-three pieces, of the 20th Infantry, under the leadership of Prof. C. Wolf, was stationed in the gallery, and played several pieces in excellent style.

The exercises were opened by prayer by Rev. Professor Jabez Brooks, D. D., after which the University choir sang an anthem.

Mr. Henry Martin Williamson, one of the graduating class, then delivered an able address on "the University," opening with a brief "salutatory," and concluding as follows: "From present indications, I trust, however, that already the people of Minneapolis are taking greater interest in the University, and that from here the infection may spread until the whole State feels a proper enthusiasm for their Uni-

versity. Our climate, and the fact that we are not like most of our sister States—cursed with a dozen starving institutions disgracing the name University—are circumstances peculiarly favorable for building up here a great University; and if we concentrate all our means and affections upon our University, we shall make it one which will be worthy of the name, and an honor to the State."

The next address was delivered by the other member of the class of '73, Mr. Warren Clark Eustis, which was full of thought and earnestness. * * * The oration was concluded with the following farewell words:

"Fellow students, preserve untarnished the fair name of our rising University. Frown down all distinctions that are not based upon moral and intellectual worth. Make our Alma Mater all that an intelligent and progressive State has a right to expect, the true centre of her educational system, the source of her richest blessings, and the mightiest agent in promoting her intellectual and material advancement."

The Hon. A. S. Welch, L. L. D., President of the Iowa State Agricultural College, then delivered an able address upon "Higher education in its transition state." The following paragraph contains the keynote of the performance:

"The learned professions and literary callings were long ago fully provided for. I would not pluck one leaf from the laurels they have gained, nor cut a single branch from their established courses. I would simply ask for the grand industrial sciences and the useful arts, which have so quickened the civilization of our era, co-ordinate opportunities and co-ordinate rank. While the learning which finds its home in our universities lends effective utterance to the sublime truths of the pulpit, and logical acumen to the labors of the bar, let it also help every industrial enterprise whose object it is to restore the earth to the beauty and the glory of its primeval paradise. Let it feed and clothe millions with more healthful food and warmer fabrics. Let it repeat everywhere the miracle of the loaves and fishes. Let it furnish the mechanic with better tools, better methods and better machinery. Let it stimulate industry and cleave the wave of every sea with its traffic. Let it beautify the surrounding landscape, crown the hills with nobler dwellings, cover the fields with more nutritious grasses and finer herds, replace the wilderness with the waving harvest, bring every farm to the topmost limit of its producing capacity, and preside over every process by which the dead mold is hanged into the marketable product.

"For when it shall have done all this, and much more, with detailed completeness, then will the University, from which it emanates, have accomplished the ends of a universal philantrophy."

CONFERRING THE DEGREES.

Hon. J. S. Pillsbury, President of the Board of Regents, then spoke as follows:

REGENT PILLSBURY'S REMARKS.

LADIES AND GENTLEMEN:—You are aware of the object for which we are gathered together. The citizens of Minnesota have watched with warm hearts the growth of their young University. After much waiting we rejoice to hear on this auspicious morning the voices of her first-born sons. They bear proof of diligent study and thorough instruction. We congratulate the gentlemen of the faculty upon this living testimony of their ability and zeal. The Board of Regents accept from them these candidates for the honors of graduation, and in behalf of this governing board, I now officially direct the President of the University to confer upon each of these young men the proper diploma of the University of Minnesota.

President Folwell then conferred the degree of Bachelor of Arts on each of the graduating class in turn, speaking in the customary Latin.

As it may be interesting to many to know the form of the first diploma given by the University, we copy it:

UNIVERSITATIS MINNESOTENSIUM PROCURATORES, OMNIBUS HAS LITERAS PERLECTURIS, SALUTEM:

Sciatis, quod N. M., studiis omnibus quæ ad gradum primum spectant, peractis, usitato more a professoribus tentatis, comprobatusque, Titulo, Graduque Baccalaurei, in Artibus, nobis auctoribus propalam adornatus est condecoratusque; simulac ei data sunt fruenda, jura, privilegia, honores, atque dignitates, quæ hic aut usquam gentium ad eundem gradum pertinent.

Cujus in rei testimonium, hasce literas, Sigillo Universitatis atque Præsidis necnon Professorum quorum refert chirographis muniendas curavimus.

Datum ex Ædibus Universitatis die — Junii, Anno Domini,— Reipublicæ Americanæ—Universitatis—

[L. S.] ——— ———, *Præses.*

——— ———, *Procuratores.*

——— ———, *Professores.*

The President then addressed the graduating class, concluding as follows:

"Do not leave college hoping for or expecting any grand career or brilliant success; but go, resolved simply to take your honest share of the work of your generation, to obey ever the call of duty, and to 'keep innocency, for that shall bring a man peace at the last.'

"Suffer me to remind you that your instruction in the University has been at large public expense, both State and national. You will not forget this benefication, but your gratitude will increase with your ages, and your ability to make returns for it. The State and the nation expect every man to do his duty, but they have especial claims upon such as you. Neglect therefore no duty of citizenship, nor refuse any clear call to public service. I ask that you will remain loyal to this University which has not been unkind nor illiberal to you. And so your Alma Mater bids you God speed."

After music by the choir, Vice President Campbell pronounced the benediction, and the exercises closed.

THE BANQUET.

The banquet tendered by citizens of Minneapolis to the Regents, Faculty, Alumni, and other friends of the University of Minnesota, was very largely attended by prominent gentlemen from all parts of the State. The presence of so many public men showed what a deep interest the whole State takes in this their chief institution of learning.

Ex-Mayor E. M. Wilson, presided, and after the excellent dinner had been amply discussed, opened the literary exercises of the banquet. He tendered to the guests present greeting in behalf of the citizens of Minneapolis, and asked the President of the Board of Regents to respond to the toast of the Regents and Faculty of the University.

Hon. J. S. Pillsbury then made a few remarks as follows:

MR. PILLSBURY'S SPEECH.

In reference to the sentiment of this toast, Mr. Chairman, I would beg leave to express my gratification at the hospitable manner in which the friends of the University are today entertained. It is a great pleasure to see on the part of the people of Minneapolis, a desire to encourage and honor the highest of the institutions of our State, and in behalf of the University, Regents, Faculty and Alumni, I would ten-

der to the citizens of this community, for the handsome banquet here afforded, our warmest thanks; indeed, I sincerely hope that the good will shown here to-day may be the forerunner of many benefactors in the future. Other communities in this and in other States have given substantial evidence of their appreciation of a University in their midst. Shall not the citizens of Minneapolis follow their example and silence the rising complaints that she is no promoter of the interests of the University?

Mr. Pillsbury then referred to what the towns in which were the leading colleges of the country, had done for them, and recommended this city to do the same.

THE PRESIDENT'S REMARKS.

MR. CHAIRMAN:

* * * * * * *

Permit me, in behalf of my colleagues, the Faculty, to return our most hearty thanks through you to the citizens who have provided this sumptuous entertainment. We make a great account of this demonstration on the part of the University town, because we know that the interest felt and thus manifested here will spread throughout the whole State.

I will engage for the Regents and the Faculty that they will spare no efforts to deserve your support. It is their fixed and declared resolution to build up an institution in which there shall be high and sound scholarship. They will stand firmly by their announcements, that no diploma shall be given which does not mean just what it says. I will say for the graduates of to-day that they *are in fact* Bachelors of Arts, entitled to be recognized as such anywhere in the civilized world. * * * * * *

Thus, Mr. Chairman, we intend to deserve your encouragement. Had we pursued a different policy heretofore, we could have shown you a larger number of graduates to-day. We prefer to fall back on the principle of the old Greek fable, familiar to all the college-bred men here. A wolf upbraided a lioness for bringing forth but one at a time. "Yes," said the lioness, "one—*one, but a lion!*" We present you twin lions, of whom we have no reason to be ashamed.

Finally, Mr. Chairman, permit me to repeat our thanks, and to wish for my colleagues and the alumni "many happy returns" of this occasion.

SPEECH OF GOVERNOR AUSTIN.

Governor Austin said:

MR. CHAIRMAN: * * * * I am glad to see so many here to-day, from all parts of the State, for I feel that this is, indeed, a great occasion. I look upon this University as the first institution of the State, and one which is to reflect greater honor upon the State than any other. The Faculty of the University need not be ashamed of their work. They need not endorse their graduates of this day as sharp business men do doubtful paper, "without recourse." I would like to see the wealthy men all over the State rally around this institution and make its cause their own. I would like to see them add to its endowments. I fear the citizens of Minneapolis do not appreciate the great advantage of this University. It is established here now for all time. You did not pay a cent to get it here. If it was in the market, looking for a location, how much would you bid? The city would now give $100,000 to secure it; and St. Paul would give $200,000. [Applause.]

You have it located here by a constitutional provision; but if you are not generous towards this favorite child of the State of which you have been made the guardian, you may sometime find that constitutional prop knocked from under, and then you will have to pay roundly if you get it. [Applause.]

* * * * * * * *

Mr. Wilson then said that all would be interested in hearing from the first Board of Regents, and he would call on Judge Atwater, Secretary of that Board, to respond:

WHAT JUDGE ATWATER SAID.

He said that it was twenty-two years ago last February since the legislature passed the charter of the University, and that then the strife came for the location of the public buildings. St. Anthony was satisfied to get the University. There was great difficulty experienced in finding a site, and after several had been proposed and rejected, the present one was decided on. That was not obtained without trouble. Col. George obtained part of the land from Mr. Cheever, and it was not until Calvin A. Tuttle came forward and donated nine acres adjoining, that the grounds were secured. The next thing was to erect buildings. It was thought best to have them, even though they had no money. Some of

Senator Ramsey said thas the pleasantest recollection of the olden time that still lingered with him, was his connection with the old Board of Regents. He was one of the most ardent supporters of the ancient triple compact, wherein it was agreed that St. Paul should have the capital, that St. Anthony should have the University, and that Stillwater should have the privilege of having all the rascals of the State. [Laughter.] * * * * * * I advocated keeping all the University lands, foreseeing that they would become very valuable, and waiting till we got rich before we built. I was overruled; the stone building was put up, and we had to sell off our lands at half price to pay off our premature debt. I do not say this to cast any reflection on my companions or on that old Board, [laughter,] but simply to explain my own position. It is all right now. These other men had more enterprise than I had, and they were better men. * * * *

I never advocated building a wooden tent. [Laughter.] That's a mistake. I *was* conservative, though. I did not advocate building at all at that time. I said "Preserve all these lands till they are valuable, and then sell them."

I am glad that the building was put up at last. The great State of Minnesota ought to be able to invite here, because of the salubriousness of our climate, students from all the less healthy States to be educated. [Applause.] And we all know that all other parts of the globe are sickly. [Laughter.] I look forward to the time when this University will compare in numbers, as it will in character, with the great University of the West at Ann Arbor. [Applause.] Minneapolis won the choicest of the favors in the ancient

division in the reputation it will give, and the wealth and fame it will bring.

The common schools of Minnesota also have the largest endowment in the West. And our civilization is worth very little without the common schools supplemented by the higher institutions. The professors and the teachers are entitled to inconceivable gratitude, working, as they do, on small salaries, in the hope of doing good and planting more firmly the foundations of the future. You are not under obligation to any set of men in society as much as you are to these men and women. [Applause.] Without the influences of our schools, all the Fourth of July talk about the beauty of flag and the glory of free government, would be hollow and worthless, and would not live a year. [Applause.]

Mr. Wilson then called on Professor O. V. Tousley to speak, as a representative of the common schools.

Prof. Tousley made an exceedingly able and forcible speech in favor of the common school system, and universal education at the public expense.

Mr. Wilson then called on Hon. Ara Barton, as a representative of the rural districts, who responded in a short and facetious address.

Speeches were then made by Hon. A. S. Welch, Rev. E. D. Neill, Ex-Gov. Sibley and Senator Talbot, which were full of good things, and we regret exceedingly that we have not the space to reproduce them.

Thus ended the exercises.

APPENDIX B.

LIST OF DONATIONS

To the Library of the University of Minnesota from June 29th, 1872, to June 21st, 1873.

Hon. Alex. Ramsey, U. S. Senator,
1 vol. Congressional Globe.
1 vol. Ninth Census, Population.
1 vol. Report of Commissioner on Education.
1 vol. Treaties of U. S. since 1776.
5 vols. Naval Observatory Publications.
7 vols. Congressional Globe.
1 vol. Ninth Census, Social Statistics.
46 miscellaneous pamphlets.

J. Ramaley, State Printer,
1 vol. Mortality—8th Census.
1 vol. Hone & Co.'s Catalogue.
18 vols. Misc. Public Documents.

Hon. C. C. Andrews, U. S. Minister to Sweden,
6 vols. Swedish Agricultural Journal.

Prof. J. H. C. Coffin, Supt. of the Nautical Almanac,
20 vols. Nautical Almanac.
1 vol. Star Tables.
9 Pamphlets. Ephemeris of Various Plants.

Hon. H. H. Oliver, Chief of Bureau Statistics and Labor, Massachusetts,
2 vols. Reports for 1871, 1872.

Maj. Gen. A. A. Humphreys, Chief of Engineers, U. S. A.,
1 vol. Explorations in Nevada and Arizona.
1 vol. Report of 1872.

Rev. E. D. Neill (author) Provost Macalester College,
1 vol. History of Virginia Company of London.
1 vol. History of Minnesota, quarto, Illustrated.
1 vol. English Colonization of America.

Charles S. Bryant, Esq., (author),
1 vol. Indian Massacre in Minnesota.

Prof. E. J. Thompson,
1 vol. Geometry.

Hon. J. S. Pillsbury,
1 vol. Kitto's Illustrated History of the Bible.

Industrial League, Philadelphia,
1 vol. Carey, H. C., The Unity of Law.
1 vol. " " Miscellaneous Works.
1 vol. " " Past, Present and Future.
1 vol. Social Science.
1 vol. Carey's Slave Trade, Domestic and Foreign.
1 vol. Byle's Sophisms of Free Trade.
1 vol. Stewart's Speeches on the Tariff.
1 vol. Sullivan's (Sir E.) Protection to Native Industry.
1 vol. Smith (E. P.) Political Economy.
1 vol. Kelly (W. D.) Speeches, Addresses and Letters.
1 vol. Elder Dr. William's Questions of the Day.

Hon. Alfred J. Hill, St. Paul,
7 Nos. The Busy West.
19 Nos. Dawson's Historical Magazine.
5 Nos. Fowler (L. N.) Illustrated Phrenological Almanac.
6 Sectional Maps of Iowa, Minnesota and Wisconsin.
Misc. Pamphlets, 29 copies.

Hon. D. H. Secombe, Minneapolis,
1 vol. Coal and Coal Oil.

Gen. F. A. Walker, Supt. of Census Bureau,
1 vol. Ninth Census.
1 vol. Report of Indian Commission for 1872.

Hon. J. T. Averill, M. C.,
1 vol. Message and Documents.

Tribune Printing Company, Minneapolis,
1 vol. Manual of Practice for the use of Bar and Bench.
1 vol. Hammon's Manual for Practice.

Col. J. E. Stevens, Minneapolis,
50 Miscellaneous Pamphlets.

Hon. Freeman Talbot, Cleveland, Minn.,
1 vol. Minnesota and the Far West.

Daniel McPherson, Minneapolis,
1 vol. Dymond, Essays on the Principles of Morality.
1 vol. Chase, Day by Day.
1 vol. Peace Principles Safe and Right.
1 vol. Murray, (L.) The Power of Religion on the Mind.
1 vol. Washburn, (I. M.) Reason and the Sword.
1 vol. Corder, (S.) Life of Elizabeth Fry.
2 vols. Seebhom, (B.) Life of Stephen Millet.
1 vol. Murray, History of America.
1 vol. Memoirs of Elizabeth King.
1 vol. Penn, (William) No Cross no Crown.

Miss Minnie Bolles,
1 vol. Beecher, (C.) The American Woman's Home.

King, Mrs. H.,
1 pamphlet, Memoir of Daniel P. King.

Hon. M. H. Dunnell, M. C.,
1 vol. Message and Documents.
10 Misc. pamphlets.

W. H. Leonard, M. D., Minneapolis,
1 vol. Art of Shorthand Writing.
1 vol. Le Noveau Testament.
1 vol. Butler, (W. A.) Two Millions.
1 vol. Jay, (W. M.) Review of the Mexican War.
1 vol. Harvey, (H.) History of the Shawnee Indians.
1 vol. Paley, (U.) Natural Theology.
1 vol. Kennedy, Preliminary Report of Eighth Census.
4 Misc. pamphlets.

W. S. Clarke, President Mass. Ag. Society,
1 Report.

Hon. Marshal P. Wilder,
1 pamphlet, Transactions.

Hon. James Brown, Mankato,
1 vol. Historical Collection of the Far West.

Prof. George H. Cook, State Geologist of New Jersey,
1 vol. Geology of New Jersey.
8 vols. Maps illustrating Geology of New Jersey.

Prof. N. H. Winchell,
11 misc. pamphlets.

Prof. J. C. Newbury,
1 vol. Geological Survey of Ohio, with maps.
1 vol. Winchell N. H., Geological Survey of Ohio.

Gov't of Dominion of Canada, through Dr. Selwyn, Chief Geologist,
1 vol. Geology of Canada, from commencement to 1863.
1 vol. Atlas accompanying Geology of Canada.
1 vol. Geology of Canada from 1863 to 1866.
1 pamphlet, Geology of Canada from 1866 to 1869.
1 pamphlet, Geology of Canada from 1869 to 1871.
1 pamphlet, Geology of Canada, Fossil Plants.

Evening Times Printing Company,
1 pamphlet, Minnesota Tourist's Guide.

R. H. Day,
1 vol. Narrative of Irish Rebellion of 1798.
1 vol. Mitchell's History of Dakota County.

APPENDIX C.

LIST OF BOOKS

Issued to Students during Year—Sept. 10th, 1872, to June 19th, 1873.

	First Term.	Second Term.	Third Term.	Total.
History	48	125	21	194
Biography	38	76	12	121
Travels	6	97	5	108
Novels	56	99	8	163
Metaphysics	20	17	13	50
Belle Lettres, Prose	53	51	13	117
Belle Lettres, Poetry	43	61	7	141
Anc. Languages and Lit	4	3	5	12
Mod, " "	7	38	8	53
Nat. Science and History	15	31	35	83
Political Science	6	24	2	32
Mathematics	78	14	3	95
Miscellaneous	80	149	12	191
Totals	398	818	144	1,360

Total No. Books Issued for Home Reading during Year	1,360
Total No. Books Issued for Reading Room during Year	370
Total No. Magazines	135
	1,865

REPORTS

OF THE

PROFESSORS OF THE UNIVERSITY.

REPORT OF PROFESSOR CAMPBELL.

UNIVERSITY OF MINNESOTA,
June 30, 1873.

To the President of the University;

SIR:—My work during the past year has been in a transition state, the organization of the departments, under my charge not being complete. For this reason my classes have not all been heard.

The following subjects have been taught by me, or by those associated with me:

Term.		Subject.	Students.
German	I.	German Grammar	55
		Iphigenie auf Tauris	33
	II.	German Grammar	56
		Evans' Abriss	26
	III.	German Grammar	23
		Jungfrau von Orleans	14
		Lodemann's Tables	18
French,	I., II., & III.	(Reported by Professor Huggins)	..
Philology,	II.	Lectures on Philology	6
Philosophy	I.	Ontology and History of Philosophy	8
	III.	Psychology	4

Respectfully submitted,
G. CAMPBELL,
Professor of Mental and Moral Philosophy, and Comparative Philology.

REPORT OF PROFESSOR WALKER.

To the President of the University of Minnesota:

SIR: I have the honor to submit the following report of the department of Latin Language and Literature for the University year of 1872-3.

The following classes have been under my instruction, viz:

One section of the IV class, in Cæsar—15 weeks.

III Class in Cicero, 15 weeks; in Virgil, 23 weeks.

II Class in Livy, 23 weeks.

I Class in Horace, 30 weeks.

Junior Class in Tacitus, 15 weeks and Juvenal, 8 weeks.

Senior Class, in the Comedies of Plautus, 15 weeks.

The following classes have been instructed by Assistant Professor Miss Helen Sutherland:

Latin Grammar and Reader, in two sections, 38 weeks.

The IV Class in Cæsar's Commentaries, in two sections, for 15 weeks.

One section of IV Class, in Cæsar, 15 weeks.

One section of IV Class, in Cicero, 8 weeks.

Latin Composition and Latin Grammar are pursued in connection with all authors read during the first three years, History and Geography with Livy, Antiquites with Horace, Literature with Juvenal or Comedies.

Reports of the number, name, attendance and progress of the students have been made each week, and at the end of each term, to the President's office.

I am unable to give a summary of students in the Latin Department as the classes reciting to the Assistant Professor were not reported to me but directly to the President's office, according to the by-law then regulating that matter.

All of which is respectfully submitted.

V. J. WALKER,
Prof. Latin.

Nov., 1873.

REPORT OF PROFESSOR BROOKS.

To the President of the University:

SIR:—Please find herein the report of my Department for the University year 1872-3.

NUMBERS.

Collegiate Department.

IV Class,	19	
III Class,	15	
II Class,	10	
I Class,	5	—49

College, Science, Literature and Arts.

Juniors,	1	
Seniors,	2	— 3
Total in Greek,		52

WORK DONE.

Studies Pursued.

Aristotle, Plato, Aristophanes, Demosthenes, Homer, Herodotus, Xenophen, Grammar and Reader, Greek Antiquities, History and Geography, Essays and written Analyses.

Lectures Given.

On Greek Literature.

Number of Class Exercises.

IV Class,	170
III Class,	169
II Class,	169
I Class,	111
Juniors,	88
Seniors,	24

Time.

To IV Class,	3 full terms.
To III Class,	3 full terms.
To II Class,	3 full terms.
To I Class,	2 full terms.
To Juniors,	1½ full terms.
To Seniors,	1 full term, (2 ex. per week.)

ASSISTANCE.

By Pres. Folwell.

III Class—Herodotus—1 term, 33 exercises.

By W. C. Sawyer.

IV Class—Grammar and Reader—2 terms, 96 exercises.

JABEZ BROOKS,
Prof. of Greek.

REPORT OF PROFESSOR DONALDSON.

To the President of the University:

SIR:—For the academic year 1872-3, I have the honor to submit the following brief report of the work done in the department of Rhetoric and English Literature.

During the first term I instructed the classical and literary juniors in the Introduction to English Literature, and two large sections of the IV. class in English Composition; during the second term, the senior class in American Constitution and International Law, the I. class in Logic, and continued English Literature for the literary juniors; during the third term, the literary and scientific sections of the I. class in Rhetoric and the entire Latin School in the Analysis of English Sentences. Mr. H. W. Slack instructed a class in English Composition, and Prof. Sawyer the III. class in History.

So far as possible, throughout the year, instruction in practical composition and elocution has been continuous in the four upper classes. One hundred and nineteen "Rhetorical Exercises," more than half of which were original, were publicly presented in the Assembly Hall.

During the year, the Honorable Board of Regents and the General Faculty have taken initiatory steps for a revision of the courses of study. Such a work is of the highest importance, and is, in my judgment, demanded by all the interests of the University, and should not be delayed longer than is imperatively necessary. Pending action in this matter, nothing further is submitted.

A. B. DONALDSON,
Prof. Rhet. and Eng. Lit.

Oct. 31st, 1873.

REPORT OF PROFESSOR THOMPSON.

To the President of the University of Minnesota:

SIR:—In accordance with the regulations of the Board of Regents, I have the honor to submit to you the following brief report of the Department of Mathematics and Astronomy, for the year 1872–3. During the first term, the department had charge of the following classes and studies:

Latin School,	2 Sections,	Higher Arithmetic.
III Class,	2 Sections,	Plane Geometry.
II Class,	1 Section,	Higher Algebra.
I Class,	1 Section,	Analytical Geometry.
Junior Class,	1 Section,	Differential and Integral Calculus.

II TERM.

Latin School,	2 Sections,	Elementary Algebra.
IV Class,	2 Sections,	Higher Algebra.
II Class,	1 Section,	Solid Geometry and Plane Trigonometry.
Junior Class,	1 Section,	Modern Geometry.

III TERM.

Latin School,	1 Section,	Eelementary Algebra.
IV Class,	2 Sections,	Higher Algebra.
III Class,	1 Section,	Bourdon.
II Class,	2 Section,	Spherical Trigonometry and Surveying.
I Class,	1 Section,	Mathematical Astronomy.
Junior Class,	1 Section,	General Theory of Equations.

The number of students in each class and the number of recitations given to each subject, is upon the records in your office and has passed out of my hands.

The pressing want of the department is a room better seated and better furnished for mathematical work. The progress of the Department of Astronomy will be very slow until it is supplied with a few pieces of apparatus, absolutely required to both demonstrate and illustrate the fundamental principles of the science.

It would add much to the convenience and efficiency of this department if the terms were of more equal length. Some

of the most important subjects of the entire course are necessarily placed in the third term of eight weeks. This affords a poor opportunity to present the leading and representative studies in the department. It scarcely suffices to introduce them. Terms of 14, 12 and 12 weeks would far better suit this department.

Respectfully submitted.

E. J. THOMPSON,
Prof. Mathematics and Astronomy.

REPORT OF PROFESSOR HUGGINS.

To the President of the University of Minnesota:

SIR:—I have the honor to submit the following report of the work and condition of the Department of Military Science for the University year ending June 20th, 1873. In compliance with orders from the War Department, I reported for duty at the opening of the fall term, September 9th, 1872.

The only instruction which as yet it has seemed practicable to give in the Department of Military Science, is practical instruction or drill in infantry tactics, Upton's Tactics prescribed by law for the army and militia of the United States being the system used. There having been no instruction in Tactics during the previous University year, I did not deem it best to organize the students into companies for drill during the fall term, and instruction was confined to squad drill, and a few of the simple company movements. There being no drill hall, military exercises were necessarily suspended during the winter, and a portion of the fall term.

In the spring the male students were divided into three companies, and exercised four times a week in company and battalion drill. A warm interest was taken by the students in these drills, and at the close of the year considerable proficiency had been attained.

The uniform prescribed is of dark blue cloth, and has been ordered by the members of two companies ("A" and "B,") comprising nearly all who design completing a course of study. A fine quality of cloth has been manufactured for the purpose by the North Star Woolen Mills, of Minneapolis, and is sold to the students at a moderate price.

The arms in use are of an obsolete pattern, and are too heavy for many of the students. Steps have been taken to procure the "Cadet Rifle Musket" used at the United States Military Academy, and also a section of light field pieces.

In addition to the prescribed military exercises, I would recommend the following course of theoretical instruction, to be optional with the student:

I. Military Engineering—to comprise the construction of field fortifications, roads and bridges, description and nomenclature of fortresses, attack and defense of works, and military mining.

II. Military History and Art of War—comprising the history and principles of Special and Grand Tactics and minor operations of war, the organization of modern armies, and method of moving and supplying them, with the history and study of celebrated battles and campaigns.

III. Military and International Law.

A drill hall and gymnasium is greatly needed. A hall 40x200 feet would, I think, answer the purpose, and the advantages to be derived therefrom are so great and obvious that I earnestly hope the necessary steps for the erection may be taken without delay.

I remain, very respectfully,
Your obedient servant,
E. L. HUGGINS,
First Lieut. 2nd U. S. Artillery,
Prof. Military Science.

REPORT OF PROFESSOR WINCHELL.

UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, E. D., MINN.,
10th July, 1873.

To the President of the University:

SIR: In the winter term, beginning Jan. 7, 1873, I took the junior class in Geology, comprising four members. The class spent the greater portion of the term on Historical Geology, using *Dana's Manual.* Preparatory to this work, they ought to have gone over the essential portions of Lithological Geology, as given in the same manual. In hope

that the heavy covering of snow would be off the ground before the end of the term, and as there were no means of illustration in the University, this was deferred till after the groundwork of Historical Geology had been mastered. The class then availed themselves of the short remainder of the term for Lithological Geology.

The first half of the same term I instructed the Third Collegiate Class in Physical Geography, giving the study a geological turn, and using Prof. Dana's *Text Book of Geology*. This class went over essentially what is there denominated Dynamical Geology. This class numbered twenty-one.

In the spring term, and during the last half of the winter term, the Third Collegiate Class studied Botany. They first went thoroughly over the "Lessons" of Prof. A. Gray. When flowers appeared in the spring, they were set to work on actual analysis of specimens, and each member of the class was required to work out independently, and properly classify, thirty or more species. Some of the class recorded over fifty species. For this purpose they made use of Morgan's *Student's Plant Record*. In Botany there were fifteen students.

In the spring term the First Collegiate Class pursued Zoology, using Agassiz' and Gould's *Principles of Zoology*. The instruction in this class was illustrated by the collections purchased of H. T. Woodman, last winter, by the Board of Regents, and was attended with a very satisfactory degree of interest and success. The class contained eleven students.

In making this report, the first on the instruction in Geology, Zoology and Botany, as a department in the University, I desire to make a few recommendations concerning the arrangement of the studies, and the time devoted to each, so as to bring them into better symmetry as a whole, and as related to the rest of the University instruction.

These sciences pertain more closely to the colleges of Agriculture and the Mechanic Arts, than to any other, and the scheme of study for them should be adapted to those colleges, rather than to that of Science, Literature and the Arts. The students in the college of Science, Literature and the Arts, should have the privilege of choosing these studies when their other classes will permit. Instead of that the present schemes of study for the sciences of Geology, Zoology and Botany, are condensed and crowded into the narrow space necessary for students who are professedly in the college of Science, Literature and the Arts, and who

generally desire but a restricted course of study in these branches. The consequence is that these sciences have not a fair representation, and are so situated that there is no opportunity, or very little, to present their full proportions, and to offer those attractions to the student that they are found to possess.

The science of Geology ought to be pursued one full year. One term for Dynamical Geology, one term for Lithological Geology and Mineralogy, and one term for Historical Geology. This should be followed by a full term in Determinative Mineralogy, with the use of the blowpipe.

The first, or Dynamical Geology, ought to come earlier in the course, and be made to include many of the principles of natural physics. It might be named instead—The Principles of Geology. I would recommend that it be substituted for Physical Geography, that study, as now taught, being an epitome of all the natural sciences.

The second, Lithological Geology and Mineralogy, with the work in Determinative Mineralogy and Blowpipe Analysis should be so placed as to follow Analytical Chemistry, and should occupy two terms in the senior year, or one in the junior and one in the senior.

The third, Historical Geology, should be so placed as to follow soon after a term's study in Lithological Geology.

In Zoology there should be two term's study, one for General Principles, and one for Systematic Zoology. At the present time two studies are named in the scheme that might very well be combined under one. I refer to Physiology and Zoology. If the term now devoted to Physiology be given to the principles of Zoology, the change would be so slight that Physiology would not be omitted, and Zoology would be fairly begun, and the following term's study on Systematic Zoology would be of far greater benefit to the student from the unification of his aim. In a post-graduate course opportunity should be afforded for special studies in classification, as one term is too short except for the merest outlines in Systematic Zoology.

In Botany there should be at least one long term. In that time the elements of Botany can be mastered, and a few hand analyses can be performed. This will be probably enough for students in the College of Science, Literature and the Arts. In the Colleges of Agriculture and Mechanic Arts another full term should be offered for more extensive study of Systematic Botany.

There is a great need of charts, diagrams and maps illus-

trative of these sciences. The collections of the Geological Survey will very soon afford specimens for very good illustration of most of the works above laid out, but these do not take the place of maps and charts. I hope that a small sum may be set aside for the purchase of such maps.

Very respectfully submitted,

N. H. WINCHELL,
Prof. of Geology.

REPORT OF ASSISTANT PROFESSOR RHAME.

UNIVERSITY OF MINNESOTA,
December 1st, 1873.

To the President of the University:

SIR: I have the honor to submit the following report of the work of my department for the year ending June 19th, 1873.

The classes under my instruction and the subjects studied have been:

FIRST TERM.

Study.	Class.	Number.	No. Exercises.
Use of Inst. Surveying....	Junior.	5	30
Use of Inst. Leveling.....	Junior.	5	35
Top. Drawing.....	Junior.	2	65
Physics.....	I.	11	65
Nat. Philosophy.....	IV.	66	65
Drawing—Plane Problems.	II.	16	65

SECOND TERM.

Descriptive, Geometry....	I.	4	65
Drawing—Elem. Projections	II.	13	65
" Use of Inst.....	III.	31	65
Mechanics	Junior.	1	50
Nat. Philosophy.....	IV.	60	65

THIRD TERM.

Drawing—Perspective.....	I.	3	30
Triangular Surveying.....	Junior.	1	30 hours
Surveying	II.	20	12
Spherical Trigonometry...	II.	20	18

On account of the absence of the Professor of Mathematics, at his request I taught the First class in Astronomy during the third term.

Mr. H. W. Slack assisted me during the first term, giving instruction to the B section of the class in Natural Philosophy.

Mr. A. M. Williamson taught both sections of the class in Natural Philosophy during the second term.

During the spring vacation, a topographical survey of the University campus was made by the members of the Junior class. The notes and map are on file in your office.

A surveyor's transit was added to our list of instruments last September. We now need very much a leveling instrument and leveling rod. The class will need these for practice next spring. I hope they will be purchased immediately, for which an appropriation has been made.

I would suggest that as soon as may be, appropriations be made for the purchase of additional instruments for the Physical Laboratory, and for models to illustrate principles in Descriptive Geometry.

Respectfully submitted,

M. D. RHAME,
Instructor in Civil Engineering and Physics.

REPORT OF MR. S. F. PECKHAM.

To the President of the University:

SIR:—Permit me to lay before you a statement of facts concerning the Department of Chemistry, which I have the honor to represent. * * * * *

In view of the increased opportunities to be offered by the University, and the probably greatly increased demands to be made upon the Department of Chemistry which will follow the completion of the new Laboratory building, provision should be made at as early a day as possible for the chemicals and reagents required. No bottles are made in this country fit for Laboratory uses, there not being a sufficient demand for the quality required to render their manufacture profitable. If allowed sufficient time I can procure them imported free of duty at a saving of 33 per cent. on their cost. To do this the entire outfit for the new Laboratory, some seventy-five or eighty dozen should be ordered,

at once, as the importers will not take the necessary trouble on small orders.

At least twenty setts of reagents, each consisting of twenty-four bottles, should be prepared before the end of the present University year. These bottles must be carefully washed and labeled, and the solutions prepared and put into them. A large number of chemicals, each in considerable quantity, which are expensive to buy, should be prepared before the end of this collegiate year. All chemicals that can be bought crude of our local druggists can be purified much cheaper than they can be bought pure of the dealers in New York. To provide for this work, which is imperatively demanded an appropriation of two hundred dollars will be required for bottles and another hundred for chemicals and labor. Unless this work is done in season it will be impossible to open the new Laboratory successfully next September, even if the building should be entirely completed, as these preperations require unavoidably a great deal of time.

If I am correctly informed the contract for the new Laboratory does not include any furniture or fixtures. In order to place the room for students, the apparatus room, the professor's Laboratory and the lecture room in working order, there will be needed the following named articles of furniture, which will cost at *least* the sums specified, viz:

(8) Eight Students Work Tables,	*a* 40	$320 00
(2) Two Cases for Chemicals,	*a* 20	40 00
(8) Eight Sinks,	*a* 5	40 00
Water Bath and Still,		500 00
Reagent Bottles,	75 doz. *a* 3	225 00
Table and Sink in Apparatus Room,		30 00
Cases in Apparatus Room,		75 00
Table and Sink in Prof's Room,		30 00
Cases in Prof's Room,		25 00
Table in Lecture Room,		30 00
Gas Apparatus,		500 00
Pumps, Tanks for Water, Drains, etc.,		250 00
Outfit of Chemicals and Apparatus,		500 00
		$2,565 00

The cost of these fixtures will be from 2,700 to 3,000 dollars, probably about the latter sum.

In closing this communication permit me to call your atten-

tion to a matter which is perhaps not strictly within my own department, and yet it is one in which my department is deeply interested, I refer to the propriety of procuring a lathe and a few tools, the cost of which need not exceed $100.00 for the use of the University. I am somewhat familiar with the use of such tools and can assure you that it would be no difficult matter to utilize the mechanical skill among the students in such a manner as in a few years to double the value of our Physical and Chemical apparatus. Few persons realize how simple in construction and inexpensive in material a large portion of our apparatus is, and also how much of it can be constructed with a few tools provided one has the time at his disposal.

All of which is respectfully submitted.

S. F. PECKHAM.

REPORT OF THE CURATOR OF THE MUSEUM.

To the President of the University:

In April, 1873, the Board of Regents devolved on me the Curatorship of the University Museum. This report is intended to give a statement of the collections that were then found in the buildings of the University, their condition and subsequent care, and to call attention to some of the imperative needs of the Museum. It will also furnish a starting point from which the future growth of the Museum may be seen by regularly recorded annual increments. In order that this history may not be incomplete, it is necessary to enumerate, by reference to the previous reports of the President of the University, the sources and the dates of reception of collections that have been placed in the University.

Prof. Washburn mentions, in his report to the superintendent of public instruction, dated Nov. 28, 1868, "one box of shells, from the Smithsonian Institution," also, "one box geological specimens from the Smithsonian Institution." He also mentions "geological specimens from various parts of the State by Prof. Moore."

In the Report of the Board of Regents to the Governor, dated December 22, 1871, the collections obtained by Prof. Campbell in Europe are referred to, as consisting of geological specimens, and photographs of antiquities and works

In the report of the President of the University for the same year a record is made of the presentation to the University by Rt. Rev. H. B. Whipple of "a valuable collection of coins, consisting of about sixty Italian, Spanish, Greek, Roman, Egyptian and Moorish specimens."

Upon examination of the boxes and open shelving holding the specimens of the Museum, it was found that there were more specimens than had ever been recorded, and that they were all in more or less confusion. Some of them were utterly uncared for, unlabeled and unboxed, the donors' names, if they ever were known, having been lost, the localities whence derived in many cases obscurely remembered or unknown, and their value for all purposes much diminished. No records had been preserved. The following list embraces a general classification and description of the specimens found, with statements of their identification when such was possible:

Twenty specimens from Ayrshire, Scotland, illustrative of the coal measures, procured by Prof. G. Campbell.

Thirty-five European minerals, some of them illustrative of the ore and iron of the Dalmellington Iron Works, Ayrshire, Scotland, procured by Prof. G. Campbell.

Seven specimens from the Trenton Limestone, showing different fossils. Donor unknown.

One specimen, a large orthoceras, from the Trenton at Mendota. Presented by Gen. H. P. VanCleve.

Thirty-two specimens illustrative of the metamorphic rocks; localities and donors entirely unknown.

One hundred and seventeen specimens from the Hamilton limestone (of Illinois?), fossils. Obtained from J. F. Kenworthy.

Thirty-seven specimens, comprising various minerals and ores. No records whatever.

Thirty-eight specimens, minerals and fossils; localities unknown; from Dr. Stoneman.

Thirty-seven specimens, well labeled and identified, illustrative of the geology of W. Rutland, Vt., and Mt. Holyoke, S. Hampton and Chester, Mass., presented by Prof. Arthur Beardsley.

A collection of about two hundred rare minerals and fossils, partially labeled, but exposed to depredations and damage. Purchased by the Board of Regents. The localities whence these specimens were derived are unknown.

A good collection of marine corals and shells, partly

labeled. Purchased by the Board of Regents from H. T. Woodman, in 1872.

A box of bones said to be those of a saurian, obtained in Dacotah.

A collection of lead ore specimens from Mine La Motte, Missouri. Presented by Mr. G. D. B. Bainbridge, student in the University, March 10, 1873.

A collection of carniferous fossils from the Falls of the Ohio, at Louisville, Ky. Presented April 16, 1873, by Mr. Clark Stewart, student in the University.

Specimens of rock from the lower Falls of Prairie River, Minn. Presented June 17, 1873, by Nathan Butler, Esq.

The first step taken toward arranging and cataloguing these specimens, was the procuring of the proper record books and the choice of a system of labeling. The work of examining and arranging proceeded as far as the time at my disposal up to the beginning of the field work of the Geological Survey would permit. But the facilities and conveniencies for storing and preservation are so poor, that there is but little inducement to work at the specimens. They are crowded into a very small room, in which there are no proper cases nor shelves. They are mingled with the philosophical and chemical apparatus. They lie on tables, on the floor, in open boxes, accumulating dust, often displaced, sometimes injured and broken, inaccessible both to visitors and to the professor who would use them for illustration in his classes. The collections of the Geological and Natural History Survey are not yet turned over to the Museum, but remain as they were received, securely boxed, each specimen carefully wrapped, with its locality expressed in a separate piece of paper. There they must remain till proper storage room is provided, and cases for their exhibition be constructed.

It is earnestly requested that a room in the University building be allotted to the Museum, and that a few appropriate cases be ordered, to contain the collections at present on hand, and to receive those that may hereafter be obtained. The private collections of Prof. Peckham and myself, would be placed on exhibition in the University Museum if the necessary means for their security were taken by the Board of Regents.

GEOLOGICAL

AND

NATURAL HISTORY

SURVEY OF MINNESOTA.

THE SECOND ANNUAL REPORT.

FOR THE YEAR 1873.

By N. H. WINCHELL, State Geologist,
AND
S. F. PECKHAM, State Chemist.

SUBMITTED TO THE PRESIDENT OF THE UNIVERSITY, DECEMBER 31, 1873.

SAINT PAUL:
SAINT PAUL PRESS COMPANY.
1874.

10.

To the President of the University:

I have the honor to offer the accompanying report on the progress of the Geological and Natural History Survey of the State, for the year 1873. The last Legislature increased the means provided for the prosecution of the survey, by doubling the cash appropriation, making it two thousand dollars annually, and transferred to the Board of Regents the State lands known as "*Salt Spring Lands*," the proceeds of which they are required to expend exclusively in the prosecution of this work. At the same time the Board of Regents of the University were required to direct the immediate survey of the peat deposits of the State, and to cause an investigation and report on the Salt Springs.

While these special investigations have been carried on as far and as thoroughly as possible, the progress of the general survey has also been pushed as far as the means and time would permit.

In general, the field of observations has been, during the season of 1873, in the southwestern part of the State. The valley of the Minnesota, and those of some of its tributaries, have been subjected to a reconnoissance which has served to answer many questions that were important to answer before entering on the detailed county work, and in that manner has also served to prolong, though not yet to complete, the preliminary survey that occupied the short season of 1872. The results of this reconnoissance, both scientific and economical, will be found stated in the proper places in the accompanying report.

The counties of Cottonwood, Jackson and Nobles have been subjected to thorough inspection for peat. Incidental examinations have also been made on peat deposits in the

counties of Dakota, Hennepin, Ramsey, Le Sueur, Nicollet, Faribault and Stearns. Prof. S. F. Peckham, the chemist of the survey, has made the analysis of thirteen specimens. Before his appointment six specimens were also submitted to Dr. P. B. Rose, of Ann Arbor, Michigan, for analysis. The reports of these gentlemen will also be found in the accompanying report, supplemented by remarks on the methods of working peat, and its value as a fuel for general use, and by sundry practical conclusions on the peats of Minnesota.

The question of the existence of Carboniferous coal in Minnesota, has also occupied considerable time during the past season. The frequent statements, positively put forth in the public prints, of the finding of considerable quantities of good coal in the southern and southwestern part of the state, together with the published opinion of Mr. H. H. Eames, reporting to the legislature in 1866, to the effect that the Carboniferous rocks of the State of Iowa are prolonged northward into Minnesota, and there furnish the "coal" of the Cottonwood and Redwood valleys, induced the attempt to determine, as far as possible, the source of the float coal found, and the real age of the rocks explored for coal in that portion of the State. This question was believed to be paramount to all others bearing on the fuel supply, and although its solution is not entirely accomplished, yet enough has been ascertained to warrant certain practical and important conclusions. The facts on which these conclusions are based, will be found stated in different parts of the following report, and need not be repeated here.

1st. The rocks that have been explored for coal, on the Cottonwood and Redwood rivers, belong to the Cretaceous system, and do not promise to be productive of coal in valuable quantities.

2d. The coal there taken out is of an inferior grade, though varying from cannel coal to charcoal.

3d. As the rocks of the Cretaceous period are believed to have existed throughout the most of the State, the only probable exception being in the southeastern portion, including half a dozen counties, such coal is likely to occur at a great many places.

4th. The "float" coal which has so often attracted the attention of the people, is derived, so far as yet known, from the disruption of the Cretaceous rocks by the glaciers of the ice period. It is scattered through the drift, and

is met with in wells and other excavations, and may be often picked up along the beds of streams.

5th. The only part of the state where good coal-bearing strata of the Carboniferous age may occur, comprises the counties of Mower, Freeborn and Faribault. As these counties are heavily covered with drift, the question can be settled definitely only by drilling or shafting to the rock. Should Carboniferous rocks be met in Faribault county, there would also be some reason for exploring for the same in the southeastern portion of Blue Earth county.

In regard to the investigation of the salt springs, nothing further has been done than to ascertain their history, and the present condition of the United States land grant. It has been found that the original grant covered 46,080 acres. Of this the State was unable to avail itself of 11,520 acres, that amount being situated outside of the area surveyed by the U. S. Government. The springs, however, lying outside of the surveyed portions of the State, were carefully located by metes and bounds, and at the order of Governor Sibley the request was entered at the Land Department at Washington that the lands appertaining to each spring so located, also those lying within the surveyed portions, claimed by the State under the act of Congress admitting the State into the Union, be withheld from sale and occupancy. They have not been so withheld, and those lands have not been certified to the State. This fact reduced the original available grant to 34,560 acres. It has been further reduced by the occupancy by settlers, 6,752 acres. About 1,600 acres were also previously covered by the terms of the act granting swamp lands to the State. The remainder, 26,435 acres, have been certified to the State. The Belle Plaine Salt Company were granted 7,643 acres of the certified Salt Spring Lands, on complying with the acts of the Legislature. The rest of the certified lands, amounting to 18,771 acres, are now available for the prosecution of the survey. The uncertified portion of the original grant, aggregating 19,872 acres, inasmuch as the whole was properly selected and located within the terms of the Enabling Act, should be the subject of a memorial to Congress, as suggested by Auditor McIlrath, in his report for 1871. It is believed that the U. S. Government would gladly make up, by an additional grant, the deficiency that has resulted in great loss to the State, through the neglect or inadvertence of its own officers.

The traveling expenses have been materially reduced

during the past season by the courtesy of the officers of the following railroads, who have granted me continuous passes over their roads, viz.: the St. Paul and Sioux City, and Sioux City and St. Paul; the Southern Minnesota; the Northern Pacific, and the St. Paul and Pacific.

Dr. I. A. Lapham, Director of the Geological Survey of Wisconsin, has furnished a catalogue of the plants of Minnesota, made up from various sources, including his own observations, and known to be growing in the state at the date of 1865. The reputation of Dr. Lapham for scientific accuracy, not only increases the value of this gift, but makes it highly desirable that its publication be not delayed. Although not strictly of a geological character, yet it comes within the scope of the survey and is herewith presented.

A great many individuals have aided in the prosecution of the survey during the past season. Of these, I can name Prof. Ira Moore, of St. Cloud, who has also donated to the University Museum a number of interesting fossils and minerals from various localities; W. Z. Haight, of Delevan, who has taken great interest in the peat investigations, and has furnished much information on the manufacture of peat in Faribault county; Gov. Stephen Miller, of Windom; I. J. Rochussen, of St. Paul; Park Worden, of Minnesota Falls; Henry Hill and A. J. Luce, of Granite Falls, and Capt. H. H. Herrick, of DeGraff, D. C. I am also under many obligations to the citizens of Cottonwood, Nobles and Jackson counties, for assistance in making the peat survey of those counties.

In the examination of the Minnesota Valley I was accompanied as far as to Mankato, and thence up the Blue Earth to Wells, by Mr. P. P. Furber, a student in the University. From Mankato to the head of Big Stone Lake, Mr. C. E. Chatfield, also a student in the University, was my only companion. The assistance of these young men contributed greatly to the thoroughness and success of the exploration of that valley. We depended on the scattered inhabitants for sustenance, and traveled with a single horse and light, covered wagon. At night we usually slept in our tent, camping near some farmer of whom we obtained meals.

Very respectfully,
N. H. WINCHELL.

THE UNIVERSITY OF MINNESOTA,
Minneapolis, Dec. 31, 1873.

I.

THE BELLE PLAINE SALT WELL.

(a) *General Section of the Well.*

The report on the Belle Plaine Salt Well, which was printed by order of the Senate, in Jan. 1872 [Ex. Docs. of Minn. for 1872, vol. I. p. 44] covered only that part of the drill above 210 feet, and pertained only to the drift materials, or to the deposits overlying the Silurian rocks. There are some reasons for believing a portion of the loose materials passed through in that distance belong to the Cretaceous. It is known that some portions of that formation consist of loose materials, and they may be mistaken for drift, especially in a region where the soft rocks of that age are not known to exist, by workmen who are not exact observers, but are prone to classify the rocks they happen to encounter according to their visible characters and the ease with which they are penetrated. The occurrence of occasional vegetable fragments is further evidence of the preglacial age of those materials. Since that report was made the well has been sunk to the depth of 710 feet.

The section of the well is thus described by Mr. P. M. Barker, who superintended the work:

Surface and drift	216	feet
Potsdam sandrock	16	"
Ochreous shale	10	"
Soapstone, variegated and mottled	40	"
Semi-igneous formation	108	"
Red shale or marl	6	"
Igneous formation	314	"
Total depth of well	710	"

(b) *Notes and Letter of A. Winchell.*

In July, 1872, samples of the preserved drillings from depths from 242 feet to 411 feet were forwarded to Prof. A. Winchell, for examination. His notes and accompanying letter to Gov. Austin are as follows:

At depth of 242 ft.—Highly magnesian clays—purple and speckled with white—mostly without siliceous grains. Generally no conclusive evidence for deciding whether drift or in place. On the whole, I think the fragments are from a formation in place. One of them contains a few quartzose grains, and has a decidedly metamorphic look. All the specimens resemble softened porphyries.

368 ft.—A mass of granules or chips, similar to above, but more uniformly red, and less unctuous. All crush under the knife and exhibit a streak lighter than the mineral—sometimes grayish.

380 ft.—Fragments still more like (242-282) but less unctuous. A broken crystal of calcite.

385 ft.—Fragment (nearly a cubic inch) of a rock, composed apparently of reddish clay and a white mineral, like magnesia or kaolin intimately mixed. The white mineral tending in places to veins. The aspect is decidedly that of a rock in place.

390 ft.—Fragments like (380) but with more calcite, and one slightly polished fragment of glassy quartzite.

398 ft.—Almost identical with (390). From the same depth, however, is a lump of adhesive clay, which is evidently produced by grinding up rock like (242-282).

400 ft.—Essentially like (242-282).

405 ft.—Essentially the same—with one fragment of quartz.

409 ft.—Same.

411 ft.—Same.

There is, in addition, a parcel of fragments from some depth not indicated. Their general character is like that of (242-282). It is easy to see that one of them is a brecciated rock composed of fragments of argillaceous character and quite soft. One is unequally cemented by a deposit of calcite.

From an examination of the specimens and a study of everything that has been written which could bear upon the question, I am led to think the rocks now being bored through, belong to the sub-silurian series—probably equivalent to the quartzite and pipestone outcropping about New Ulm and in Pipestone county, Minnesota. (White, Io. Rep. I, pp. 169, 170; Shumard: Owen's Rep. p. 491.)

LETTER TO GOV. AUSTIN.

Ann Arbor, Mich., 12 Aug. 1872.

Gov. Horace Austin, St. Paul, Minn.,

SIR: Yours of the 24th of July was found awaiting me

on my return from the east, though the case of specimens did not arrive until August 5th, when I was prostrated by an obstinate fever, which has continued for a week. Improving such opportunities as I have had, I have made a pretty thorough physical examination of the specimens and reviewed all that has been published on the question of their identification and their relations to the geology of Belle Plaine, and I would respectfully report as follows:

1. Neither your note nor the accompanying one from Mr. Hooper intimates whether the materials passed through below 200 feet are wholly of the kind sent, or whether these fragments and masses were found mixed with much clay and sand, and even hard pebbles.

I infer, however, from an inspection of the specimens, that they are samples of rocky strata found in place.

At the same time, their uniform softness, for 200 feet, is very remarkable, and would suggest that the drill is passing through strata which are highly tilted.

2. Mr. Hooper informed me, last year, that at 202 feet a shelly rock had been reached, which, at 210 feet, became solid sandstone and constituted a bed-rock. I inferred that this was the Potsdam Sandstone, and still think that whatever there was of it, belonged to that formation. Between 210 and 242 feet, I have no information; and it appears that the sandstone, [a lower sandstone than that at St. Paul,] was completely pierced in that interval or less. The old well was, therefore, very near the bottom, or perhaps quite at the bottom of the sandstone. The ancient valley of the Minnesota river, which probably once discharged the waters of a much wider hydrographic basin, was eroded completly to the sub-silurian rocks.

3. These sub-silurian rocks are very remarkable. All the samples are agillo-magnesian, mostly fine-grained, unctuous, sometimes lined and frequently speckled with a white mineral like magnesia or kaolin. They present almost no grains of quartz, but sometimes inclose crystals and seams of calcite. The color is reddish and purplish. Viewed without a test for hardness, they look like vitreous porphyry. I am led to think they represent the formation known to outcrop at New Ulm and in Pipestone county. These clays, in fact, are substantially the catlinite or "pipestone" so well known in that county.

4. If these conclusions are correct, there is no hope, either of salt or a well of fresh water, by boring deeper, and not another dollar ought to be expended in this hope.

5. It will be noted that my recommendation in my former report suggested the propriety of boring *only to the bottom of the Potsdam Sandstone.* As there intimated, there are certainly many regions in Minnesota, where a well bored to the bottom of this formation, would prove to be artesian. Belle Plaine, as I feared, does not prove to be favorably located. Places suitable for borings, at public expense, ought to be intelligently selected, without any regard to the interests of localities, and the State ought not to be committed to unwise expenditures by the precipitate and ill-advised enterprise of smart business places.

Lest this remark, however, should be thought to apply too severely to Belle Plaine, I ought to add that considerable reason existed for boring at that place—though by no means as good reason as many supposed. The fault committed here, as in so many other cases, was an attempt to proceed independently of geological knowledge in the beginning, and to call for scientific aid, not so much to guide an important enterprise, as to help it out of difficulty.

Very respectfully,

A. WINCHELL.

(c) *Notes and Report of N. H. Winchell.*

In February, 1873, the writer had occasion to further examine this well, under verbal instructions from Gov. Austin. Samples preserved by the owners from below the depth of 411 feet, were found to have the following external characters. The memorandum is here given, as well as the report subsequently made to Gov. Austin, in order to preserve to science the record of the drill, and to complete the history of the exploration:

At 420 ft.—Ferruginous quartzite, with a considerable admixture of light-colored, softer, apparently talcose fragments. The quartzite is hard, and very impure. The talcose fragments are either nearly white or speckled with rusty and black spots. There are also in the drillings pieces of calcite, a soft, greenish substance that may be silicate of iron, and occasional fragments of translucent quartz, either white or slightly tinted with yellow or with green.

At 430 ft.—A mixture of dark brown or reddish silicates, strongly ferruginous, with slight traces of mica and some pieces of calcite. Some of it appears conglomeritic, or tufaceous. It is slightly unctuous in the fingers, and some of it is real iron ore. The light-colored pieces of the last (420 feet) are rarely seen. There are in it occasional greenish pieces of quartz. It is evidently a metamorphosed sedimentary rock.

At 440 ft.—A ferruginous, unctuous shale, with very little grit. It sometimes is spotted with a white substance about as hard as talc, which has a greasy feel. This white substance seems to be the same as mentioned in the foregoing. It is sometimes minutely disseminated among the ferruginous portions. When then rubbed in the fingers, a rusty or irony stain covers the whole. Some of this is plainly siliceous and micaceous.

At 450 ft.—About the same as at 430 ft. but darker colored and less firm in the fingers. It is plainly micaceous.

At 460 ft.—Dark greenish-brown, micaceous silicates; hard and compact. Not evidently unctuous. No feldspar is discernible.

At 470 ft.—A talcose, ferruginous shale, of a reddish-brown color, with occasional pieces of greenish silicates. In this lot there are also several pieces of evident flesh-colored feldspar.

At 480 ft.—A mixture of ferruginous silicates with some mica and talc and calcite; with occasional pieces also of the soft, greenish substance mentioned at 420 feet. The last is softer than calcite. The general color of the whole is dark red or brown.

At 490 ft.—The same as at 480 feet.

At 500 ft.—The same as at 480 feet.

At 510 ft.—The same as at 480 feet, but more friable, apparently, as the sample is in the form of sand. There are also in this lot several large fragments of ferruginous shale, which have a greasy feel, probably broken from the overlying beds by the bucket and brought up with the drillings.

At 520 ft.—A very dark, ferruginous mixture of the various silicates, including the light green soft substance, resembling silicate of iron. This last also resembles talc, and is as soft.

At 530 ft.—A red arenaceous shale, with some talc and calcite, and also fragments of flesh-colored feldspar.

At 540 ft.—The same as at 530 feet.

At 550 ft.—Fragments of dark red, coarse shale, like the last, and of a darker slightly greenish shale, that appears as if originally amygdaloidal, the cavities having been subsequently filled by the soft green substance mentioned at 520 ft. This latter mass is sometimes closely mixed with small geodes with rusty exterior.

At 570 ft.—A dark brown shale, like the dark shale in the last, closely mingled with the soft, greenish (silicate of iron?)

At 580 ft.—The same as at 570 feet.

At 590 ft.—The same as at 570 feet, but showing a little more red, and also evident pieces of calcite.

At 600 ft.—The same as at 590 feet, but with increasing quantities of the greenish, soft substance.

At 614 to 620 ft.—A mixture of the various silicates with considerable iron, the quartzitic characters being much more evident than at 570 feet. It is also firmer—hardly a shale.

At 620 ft.—The same as the last.

The well is said to be 710 feet in depth, and the opinion is prevalent that there was no change from 620 feet to that depth. As there are no preserved samples below 620 feet, it is also probable that there was no marked change in the rock. If that be correct, it gives a thickness of 292 feet of rock, which may all be classed as a siliceous, unctuous shale, highly ferruginous, and sometimes amygdaloidal, va-

rying to a micaceous quartzite. It seems to be a metamorphosed sedimentary rock, lying below both the St. Croix Sandstone and the Potsdam Sandstone.

On the basis of these notes was made the following report:

REPORT TO GOVERNOR AUSTIN.

THE UNIVERSITY OF MINNESOTA,
ST. ANTHONY, MINN.,
8th Feb. 1873.

Gov. Horace Austin, St. Paul, Minn.:

According to verbal instructions from you, given on the 6th instant, I proceeded yesterday to Belle Plaine, for the purpose of making examination of the premises and the preserved samples of the drillings from the well sunk at that place, for testing the rocks for brine. The object of my visit was to ascertain the propriety of further expenditure by the State at that point, either for the purpose of proving the rock further for brine, or for purely scientific results.

I did not enter into a careful examination of the derrick and machinery, but suppose them to be, as represented, in perfect order, and ready for operation at any time. The springs that are said to be briny are situated near the drilled well. I obtained a sample of the water for analysis. To the taste it does not show brine, but a careful examination may prove it to hold a small amount of salt.* These springs issue from the base of the drift bluffs that enclose the river valley, and, according to all the information I could gather, are dependent altogether on the surface deposits for their supply. The owners of the well also say they have met no indications of brine in the well since they struck the rock, but that at varying depths in the drift materials, the water pumped out showed more or less saline property. The drift materials are said to have proved to be there 216 feet in thickness.

The preserved drillings which I examined pertain to that part of the well below 420 feet, and I can report only on that portion of the well. They extend moreover only to the depth of 620 feet. The well is said to be 710 feet deep. Without entering into details as to the character of those drillings, a matter that will find place in my next annual

* See the report of Prof. Peckham.

report, I may say that they consist in general of a siliceous, apparently talcose, shale, varying to a micaceous quartzite. It seems the whole thickness covered by the drillings I saw, is taken up with a metamorphosed sedimentary rock that lies below the St. Croix Sandstone, and also probably below the Potsdam Sandstone. Hence the bottom of the well is in the Huronian slates and schists, but has not yet struck the granite. In this statement it is presumed that the interval unrepresented by drillings (from 620 feet to 710 feet) is filled up, according to the opinion of the owners, by the same general class of rocks. I have no hesitation in saying that *in the rocks of that age there is almost a certainty that no salt would be obtained, and that no lower formation would offer better inducement to sink the well deeper.*

The only other reason for sinking the well deeper is on purely scientific grounds, viz.: to ascertain the character of the rock below the present bottom of the well.

In respect to this I wish to say:

First.—The well is not located where the most light could be thrown on the geology of the state by such an exploration. There are vast districts where even the nature of the outcropping rock at the surface is unknown, to say nothing of those that succeed it in descending order. The geology of the vicinity of Belle Plaine is pretty well made out, especially in the light of the developments of this well.

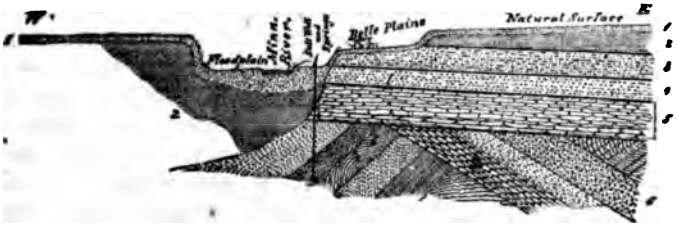
Second.—The rocks that would succeed that in which the drill stopped would be best examined where they are abundantly exposed at the surface. They belong to the class of "granitic and metamorphic" rocks, colored on my preliminary geological map of the state, and our knowledge of them is at present so limited, that before their natural outcrops are examined carefully, it is not certain that we should derive satisfactory and useful information of their nature, by sinking a drilled well through them, or into them. They are the rocks, moreover, that are least likely to need such exploration, on account of their being extensively tilted and broken by early volcanic forces so as to expose their thickness and contents to the inspection of the geologist.

Third.—It cannot be denied that the science of geology might be considerably advanced by sinking this well deeper, presuming all the time that careful records be kept and samples be submitted to a geologist for examination. It is

at the same time certain that no important question, involving the geology of the state, is pending on what might be developed.

The question may arise—if there is salt in the water at Belle Plaine, what is its source, and can it be made useful? If there be salt in the spring water there, it must issue from some part of the drift. It may be derived at first from some of the underlying formations, as the St. Croix Sandstone, or the Lower Magnesian Limestone, or it may come from the Cretaceous, which lies in many places unconformably on all the older rocks, but is generally deeply covered by drift. In either of these cases it would be best and soonest developed by drilling at some point east of Belle Plaine, say fifteen miles, as the rocks dip in that direction. The annexed diagram illustrates the situation of the well drilled, in respect to the rocks, and shows the positions of the formations and their dip. None of these formations, however, are known to contain brine in this country, if we except doubtfully the Cretaceous, while yet it is theoretically true that any sedimentary formation, if porous, may hold brine, if so shaped that it has not drained out.

DIAGRAM OF THE GEOLOGICAL RELATIONS OF THE BELLE PLAINE SALT WELLS.



No. 1.—Drift. No. 3.—Low. Magnesian. No. 5.—Potsdam Sandstone.
No. 2—Cretaceous. No. 4. St. Croix Sandstone. No. 6.—Metamorphic and Granitic

In conclusion, I am at present of the opinion that if there be salt in the springs at Belle Plaine, it is derived from the Cretaceous rocks, but manifests itself in the drift at the base of the river bluffs, because the surface drainage is in that direction, there being a slow but constant loss of brine by that means. This subject ought to have early attention.

I wish to call your attention to the necessity of combining the records and minutes made prior to the depth of 420 feet, with those I have made on the drillings below 420 feet, so that the whole be preserved to science. The owners think those samples were forwarded by you to Ann Arbor, Michigan, and that a letter from my brother to you has some mention of them.*

Very respectfully,

N. H. WINCHELL.

THE UNIVERSITY OF MINNESOTA,
February 16, 1874.

Prof. N. H. Winchell:

MY DEAR SIR:—In answer to your enquiry in reference to the progress of the analysis of the Belle Plaine water, I have to report, that while the work is not yet completed, enough has been done to show that it contains only a small proportion of chlorides of any kind, and also to justify the statement that the brine belongs to the class of "bitter brines," containing more sulphates than chlorides, and a larger proportion of alkaline earths (lime and magnesia) than alkalies (soda and potash.) I have found nothing as yet in my examination of this mineral water to justify the expectation that it can be made of any commercial value as a source of common salt.

Very truly yours,

S. F. PECKHAM,
Chem. Geol. Survey, Minnesota.

* This letter has already been given—See p. 80.

II.

PEAT.

(a) *Need of Fuel—Objects of the Peat Survey.*

The absence of wood and coal from a large part of the settled portions of the State, and the consequent high price of fuel for domestic use, induced the last Legislature to insert a clause in the "act to aid the Geological and Natural History Survey," requiring the immediate survey of the peat deposits of the State, a report on the same to be made to the Legislature as soon as practicable. In that way it was hoped that a good fuel might be obtained, practicable for all the common uses of the settler; and that a great many of the hardships of the first settlers of the prairies of the State would thus be relieved. While this law was not intended to work a suspension of the other geological investigations required by the general law creating the survey, its immediate and practical importance has nevertheless controlled the course taken in the routes of exploration, and absorbed much of the time throughout the whole season.

Allied to the subject of peat is that of coal. It was deemed best that the two should be prosecuted together, especially as the locality of the rumored coal exposures coincided with that of the greatest need for fuel, and again with that in which peat was supposed to exist. The southwestern quarter of the State, including the Minnesota valley and those of some of its tributaries, have occupied the principal part of the season. In addition to these explorations, the counties of Cottonwood, Jackson and Nobles have been pretty thoroughly surveyed for peat. The northeastern portion of Jackson and the northwestern portion of Cottonwood should be further examined. The question of the occurrence of coal, and its origin and nature, is mentioned under the head of "The Economical Geology of the Minnesota Valley."

(*b*) *The Varieties of Peat.*

In order to a perfect understanding of that which follows, it will be well to mention the different varieties of peat, briefly describing the nature and habitat of each, and the terms by which they will be designated. The different products of a vegetable nature that have attracted attention under the general term *peat*, and have served to some extent for fuel in the State, may be classified as follows:

1. Slough peat.
2. Side-hill peat.
3. Turf-peat.
4. Turf.

Only to the first two of these is the term "peat" properly applied, yet among the common people they are all frequently embraced under that term.

1. *Slough Peat*, is that which is found in low ground, occupying the lowest spots in old drainage courses which are now either entirely destitute of currents of running water, or are only filled in the wet seasons of the year, or occurring in the depressions among the drift hills or knolls, the slow drainage from which prevents the accumulating water from standing for too great a length of time above the usual level. In southwestern Minnesota such peat must be so situated also that the slough which holds it never becomes dry, else the prairie fires will certainly consume it. Hence, the necessity of constant springs of water to supply the slough in the dry months of the year. This again implies that the surface of the country must be rolling, at least that some bluffs of drift gravel must lie adjacent to the slough to give origin to springs of water. These springs are very often invisible. Their existence may be known, however, by the standing of the water of the slough at the same level, even in the dryest seasons. In case such peat lies in an old drainage course which shows no great flow of water in the dry season, the low spots containing it are still supplied with water enough to preserve the peat, by the slow, invisible, underground drainage pertaining to the valley. These correspond to the German *Wiesenmoore*.

The primary and essential ingredient that goes to form this kind of peat is a fine moss that grows over the surface of the bog, among the coarse stalks of other vegetation, such as grasses or rushes, making a handsome green surface. At a distance this moss cannot generally be seen. It is hid by the coarser vegetation. Besides this moss, the

roots and decaying stems of the grasses and other aquatic plants that may grow in the slough, also aid in the peaty accumulation. This moss is *Sphagnum palustre*,* and the aquatic plants that accompany and hide it are bulrush (*Scirpus*), scouring rush (*Equisetum*), a short "blue-joint" grass, and occasionally the cat-tail (*Typha latifolia*), and species of *Polygonum*, and some others.

There is, besides the typical moss peat of the sloughs, a pulpy deposit in the bottoms of many small lakes and ponds derived from the coarse grasses and sedges that grow about their margins, which consists principally of vegetable matter, and if treated properly will make a useful fuel. It is in the form of a fine silt, and is usually too limited in quantity, and too impure in quality to be very valuable. It is apt to be most abundant on the leeward side of the lake, where the prevailing winds have driven it, and the waves have beaten and broken it. This corresponds to the *Schlammtorf* of Holland.

2. *Side-hill Peat.*—This is formed on the side of a gentle declivity where springs of water furnish the necessary constant moisture. It is apt to accompany those springs that lie in belts, marking the outcropping upper edges of shale beds or other impervious rock. It is composed of the same materials as slough peat, but is more liable to be impure, from the sand and dust that are carried upon it by the high winds of the plains. Such peat may accumulate to the depth of six or eight feet. It is far less common in southwestern Minnesota than slough peat. It requires also a rolling surface that may give rise to unfailing springs. Many springy side-hills that in a moister climate would become peat-bearing, dry up in summer to such an extent, in southwestern Minnesota, that no aquatic plants can survive, and no peat can be formed on them.

3. *Turf-Peat.*—This is formed of the roots and fallen stalks and blades of the rank grasses and sedges that grow in the shallow sloughs, or about their margins, in situations moist enough to resist the prairie fires. It is found sometimes on a side hill or in a narrow ravine or inclined slough through which there is a slow seepage of water. It is always more impure than the foregoing varieties, and becomes mixed with sand and black mud below the depth of 12 or 18 inches, so as to render it unfit for use. It is always fibrous and conveniently handled. Owing to its being so

* This is the common term. Dr. C. A. White has, however, given the name *Hypnum adunctum* to the peat moss of Iowa.

hard as to support the weight of a man, or often of a team, in the dry months of the year, its accessibility and the ease of taking it out by simple means, it is probably the most useful variety of peat to the farmers of southwestern Minnesota. It is also the most common. In very dry seasons the fires get into this turf-peat and consume vast quantities, burning for several weeks, or even till mid-winter. It is invariably found about the margins of the little depressions in the general prairie which contain water in the spring of the year, but become nearly or quite dry in the summer. The peat itself is annually submerged for several weeks in the spring. It lies on a hard and impervious drift clay, which is generally very fine, and blackened to the depth of a foot or more by the charred vegetation of many generations.

4. *Turf.*—This is the common sod of the prairie. It passes into the last. It is made of the prairie grass roots, and those of other vegetation that may grow there. In dry sloughs, that furnish a fine growth of hay annually, it is sometimes fit for fuel, but it rarely becomes thick enough to make it of much use for that purpose. It always contains considerable sand and clay.

(c) *The Quality of Minnesota Peats.*

There is nothing in Minnesota, so far as yet discovered, that answers to the extensive *moors* or *heathers* of the moist climates of Ireland, Holland and North Germany. They occur on the northeast coast of North America, in Labrador, Newfoundland and Anticosti, where the summers are not so excessively warm, and where frequent fogs give the atmosphere that state of moisture which the peat mosses require. Along the low lands on the south coast of Anticosti "a continuous plain covered with peat extends for upwards of eighty miles with an average breadth of two miles; thus giving a superficies of more than a hundred and sixty square miles."* It has a thickness of three to ten feet. In the wooded portions of the State the peat deposits are likely to be made up of more or less coarse vegetation, such as deciduous leaves, and the stems and roots of various ericaceous plants. In the extensive peat deposits of the old world the vegetable fiber is entirely destroyed below a depth of ten or fifteen feet, and the peat has a compact, earthy texture, and a black or brown color.

* Geology of Canada, 1863.

The peat deposits of Minnesota are, so far as known, too shallow to exhibit this perfect decomposition, and hence, they are generally distinctly fibrous from top to bottom. In the lower portions of the deep peat bogs of Ireland the per cent. of ash is much greater than near the surface, reaching sometimes as high as nineteen per cent. those portions near the surface, which contain the vegetable matter but little altered, affording but one and a half per cent. Thus, while the density of peat, and hence its usefulness for domestic fuel, are enhanced by the greater depth, its combustibility and its purity are diminished. The superficial layers have nearly the same composition as wood. The foriegn substances, that constitute the ash of the lower portions, are lime, silica, iron and clay. The lime is derived from the small shells that often inhabit the bog, and which sometimes are so abundant as to have caused, by their accumulation, a bed of shell-marl at the bottom of the lake before the growth of the peat mosses filled it. Such shell-marl beds often occur at the bottom of peat bogs. Silica may have entered the growing peat by being blown on in the form of sand, or washed in by freshet rains from the adjoining hills. Iron is found in nearly all water in its natural state. As a carbonate it may be carried in solution by spring water issuing from ferriferous gravel or sand. On exposure to the air it is converted to a hydrated peroxyd, which is precipitated as a red film on all substances. If long continued it would thus form a bog ore, or brown hæmatite. It would descend by its specific gravity to the bottom of the peat bog. The clay that makes a part of the ash of peat is a composite substance. Its chief ingredient is alumina. It may also be carried into the bog by small streams so as to mingle with other impurities in the greatest proportion at the bottom. By reference to the accompanying chemical analyses, performed by Dr. P. B. Rose, of Ann Arbor, Mich., and by Prof. S. F. Peckham, chemist of the survey, it will be seen that a great diversity exists in the qualities of the samples of peat from Minnesota, but that they compare favorably with peats analyzed from Iowa, Connecticut, or even the famous Irish peat.

(d) *Peat Analyses by Dr. Rose.*

Of the peats analyzed by Dr. Rose, the samples numbered 1 and 2 were procured and furnished the survey by Dr. C. D. Williams, of St. Paul. No. 3 was furnished from

the manufactory by W. Z. Haight. No. 4 was obtained by the survey, and is named in the section describing it, "Peaty, Lake Sediment." No. 5 is properly not a peat, but a turf-peat, as defined on page 90. No. 6 is a fair sample of raw peat, from Wells, in Faribault county, obtained by the survey. The corresponding serial numbers in the records of the survey, run from 5 to 10 inclusive.

Prof. N. H. Winchell, State Geologist of Minnesota, St. Anthony Falls, Minn.:

DEAR SIR:—The six samples of peat furnished me by express, and marked as follows:—

No. 1—Schmidt's land, St. Paul—taken out eight feet below the surface;
No. 2—Schmidt's land, St. Paul—two feet below the surface;
No. 3—Manufactured peat, from Wells;
No. 4—Lake Emily, near St. Peter;
No. 5—Empire City;
No. 6—From Wells, not manufactured;—

have each been submitted to an analysis, with the following results: 100 parts of the air-dry peat contain —

	Hygroscopic Water.	Ash.	Organic Matter.
Peat No. 1 (Serial No. 5).....	13.75	12.73	73.52
Peat No. 2 (Serial No. 6).....	12.65	21.67	65.68
Peat No. 3 (Serial No. 7).....	14.00	18.17	67.83
Peat No. 4 (Serial No. 8).....	9.83	67.17	23.00
Peat No. 5 (Serial No. 9).....	8.83	77.35	13.82
Peat No. 6 (Serial No. 10).....	15.95	18.17	65.88

The ash, or inorganic matter, varying greatly in quantity, was still further subjected to analysis, with the subjoined result:—

Peat Ash.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Silica.....	49.09	65.39	58.31	88.95	59.37	61.32
Potassa.....	.63	.57	.41	.12	.14	.55
Soda.....	.37	.31	.18	.11	.08	.23
Lime.....	13.87	10.60	14.18	1.43	18.10	12.44
Magnesia..... ...	3.01	2.24	2.90	.82	1.41	2.43
Iron and Alumina.	14.92	6.31	10.21	7.04	6.58	9.71
Sulphuric Acid....	8.23	8.34	2.11	.12	.14	2.37
Carbonic Acid	10.27	5.97	11.63	1.32	14.12	10·69
Phosphoric Acid..	Trace.	Trace.				
Chlorine.....			Trace.			Trace.
	100.39	99.78	99.70	100.70	99.94	99.96

The following is the elementary analysis of the organic matter:—

	Per 100 of the Organic Matter.			Per 100 of the Original Air-dry Peat.		
	Carbon.	Hydrogen.	Oxygen & Nitrogen.	Carbon.	Hydrogen.	Oxygen & Nitrogen.
Peat No. 1.....	53.06	6.19	40.75	39.03	4.56	29.93
Peat No. 2.....	52.22	6.11	41.67	34.30	4.01	27.37
Peat No. 3.....	52.02	6.68	41.30	35.30	4.54	27.99
Peat No. 4.....	48.66	9.73	41.61	11.19	2.24	9.57
Peat No. 5.....	46.58	10.51	42.91	6.44	1 45	5.93
Peat No. 6.....	51.94	6.17	41.89	34.22	4.06	27.60

The composition of the above samples of peat compared with that of *hard wood* is as follows:

	Carbon.	Hydrogen.	Oxygen and Nitrogen.	Ash.	Water.
Wood.....	39.6	4.8	34.8	0.8	20.0
Peat No. 1.....	39.03	4.56	29.93	12.73	13.75
Peat No. 2.....	34.30	4.01	27.37	21.67	12.65
Peat No. 3.....	35.30	4.54	27.99	18.17	14.00
Peat No. 4.....	11.19	2.24	9.57	67.17	9.83
Peat No. 5.....	6.44	1.45	5.93	77.35	8.83
Peat No. 6.....	34.22	4.06	27.60	18.17	15.95

The heating power of each of the six samples of peat, as compared with an equal weight of air-dry oak wood, is based on the amount of oxygen required for complete combustion, or by the number of pounds of water raised from 32° to 212° F.

100 lbs. of the air-dry peat No. 1 = 104.2 lbs. of oak wood.
100 lbs. of the air-dry peat No. 2 = 94.7 lbs. of oak wood.
100 lbs. of the air-dry peat No. 3 = 98.1 lbs. of oak wood.
100 lbs. of the air-dry peat No. 4 = 34.4 lbs. of oak wood.
100 lbs. of the air-dry peat No. 5 = 16.9 lbs. of oak wood.
100 lbs. of the air-dry peat No. 6 = 89.6 lbs. of oak wood.

All of which is most respectfully submitted.

P. B. ROSE,
Asst. in Chemistry, University of Michigan.

Chemical Laboratory, University of Mich., Nov. 22, 1873.

(e) *Peat Analyses by Prof. Peckham.*

Prof. N. H. Winchell, State Geologist of Minnesota:

My Dear Sir:—The following is a report of the chemical investigations conducted in accordance with your suggestions for the Geological Survey of Minnesota:

I desire to state that when I assumed the duties of Chemist to the Geological Survey last August, I found absolutely nothing in the University laboratory in preparation for special investigations of the nature of those I was about to undertake. The room in which I have worked had to be fitted up. Much of the apparatus used had to be procured from New York. All my solutions of reagents had to be prepared, as well as many of the reagents themselves. In fact I began at the beginning and fitted up my laboratory before doing any of the work at hand. I have also discharged at the same time the duties of a full professorship in the University, and have consequently only been able to give the work of the survey the second place.

No. 1. *Tripoli.*—You have placed in my hands for examination a specimen of Tripoli, or very fine grained, friable sandstone, of which 25.15 per cent. was found to be soluble in boiling concentrated hydrochloric acid. The remaining 74.85 per cent. consisted of microscopic, apparently angular fragments of white quartz. The soluble portion consisted chiefly of Ferric oxide (Fe_2O_3) and a smaller portion of the carbonates of lime and magnesia, of which quantitative determinations were not made.

"*A.*" *Clippings of Native Copper.*—A specimen which I have marked A, of which I have made the following record: A letter was handed me addressed to Prof. Winchell by R. S. Russell, of Pleasant Grove, Olmsted Co., Minn., containing an enclosure of minute fragments or clippings of what appeared to be native copper. "Found on the south bank of Root River in the neighborhood of green shale * * imbedded in loose rock found on the surface."

Completely soluble in dilute nitric acid. Evaporated to dryness the residue was completely soluble in water and contained nothing but nitrate of copper.

Mineral Water.—A pint of mineral water not labeled. It appeared not to have been filtered. The results of as complete a qualitative analysis as the small quantity would admit of, are as follows:

The water contained a brown, flocculent deposit and crys-

talline scales. It was neutral to litmus, tumeric and lead papers, showing the absence of free acids, alkalies and sulphuretted hydrogen. It was also odorless, with a bitter saline taste.

Three hundred and ninety-three cubic centimeters were evaporated to dryness. A portion of the residue dissolved in water contained potassium, sodium, chlorine, sulphuric acid and a trace of phosphoric acid. The residue insoluble in water, dissolved in hydrochloric acid with escape of carbonic acid, and the solution contained chlorides of lime and magnesia.

These results indicate that the water held in solution:

Carbonate of lime,
Carbonate of magnesia,
Chloride of sodium and potassium,
Sulphate of sodium and potassium,
Phosphates, a trace.

A little organic matter was not dissolved in hydrochloric acid.

This water will be further examined.

No. 29.—A specimen supposed to be carbonate of magnesia, was found to be a light-colored, friable clay, containing a large proportion of sand; will be still further examined.

Nos. 30 *and* 31.—Two specimens of siliceous limestone, containing small, rounded grains of a soft, light-green mineral, were to be examined for carbonate of copper. Dilute hydrochloric acid dissolved the lime with disengagement of carbonic acid. The hydrochloric acid solution was colorless and contained lime, iron, magnesia and a trace of manganese, with carbonic and silicic acids, but no copper. The insoluble portion consisted of grains of quartz sand, and the green mineral which contained iron, alumina, magnesia and soda, with silicic acid. This green mineral has the appearance of being green slate, in water-worn grains. The species can only be accurately determined by a quantitative analysis. They will be still further examined.

Peats numbered 16 *to* 28 *inclusive.*—Thirteen specimens of peat were examined with reference to hygroscopic water, organic matter and ash. They were all treated exactly alike. An average sample of each of the specimens was finely pulverized and thoroughly mixed. Of this one gramme was carefully weighed in a one-ounce platinum crucible. The covered crucible containing the assay was then placed in an air bath, and heated to 212–220 degs. Fahr., until it

ceased to lose weight. The loss was estimated as hygroscopic water. The cover was then removed, the crucible inclined and heated to dull redness, finally to bright redness, until the combustible matter was entirely consumed. The loss was estimated as organic matter and the residue as ash. The following results were obtained:

No.	Hygroscopic Water.	Organic Matter.	Ash.
16	12.72	68.52	18.76
17	13.04	48.64	38.32
18	10.99	44.56	44.45
19	20.64	53.60	25.76
20	16.75	47.03	36.28
21	11.93	33.48	54.59
22	13.58	53.28	33.14
23	11.03	41.67	47.30
24	10.225	64.475	25.30
25	10.80	16.33	72.87
26	8.69	31.90	59.41
27	9.85	42.63	47.52
28	29.44	58.17	12.39

These Peats will be still further examined.

An absolutely accurate comparison of these Peats with oak wood cannot be made without a determination of the carbon and hydrogen present in each; but in order to furnish a tolerably correct basis of comparison, the average amount of carbon and hydrogen as compared with the total amount of organic matter, was estimated in the six specimens examined by Dr. Rose. It was found to be 58.4 per cent. The proportion contained in oak wood being made the standard of comparison or 100 per cent., all of the Peats examined by Dr. Rose and myself, were found to possess the following values, 100 pounds of the air-dry substance being taken in each case:

100	lbs.	Oak Wood	=	100.0	lbs.	100	lbs.	No. 19	=	70.5	lbs.
"	"	Serial No. 5	=	99.0	"	"	"	" 20	=	61.7	"
"	"	" " 6	=	86.0	"	"	"	" 21	=	44.0	"
"	"	" " 7	=	89.3	"	"	"	" 22	=	70.1	"
"	"	" " 8	=	30.2	"	"	"	" 23	=	54.8	"
"	"	" " 9	=	18.1	"	"	"	" 24	=	84.9	"
"	"	" " 10	=	86.7	"	"	"	" 25	=	21.4	"
"	"	" " 16	=	90.2	"	"	"	" 26	=	42.0	"
"	"	" " 17	=	64.0	"	"	"	" 27	=	56.1	"
"	"	" " 18	=	58.6	"	"	"	" 28	=	76.5	"

No. 28 was one of the first examined, and was not probably sufficiently dried, as the amount of water is very large, 29.44 per cent. The ash is only 12.39 per cent., however, which is very low. This peat is no doubt very nearly as valuable as number 16, when properly dried.

The value of all of these peats, as compared with each other, is as follows:

1	Ser. No. 5	7	Ser. No. 28	13	Ser. No. 27
2	" 16	8	" 19	14	" 23
3	" 7	9	" 22	15	" 21
4	" 10	10	" 17	16	" 26
5	" 6	11	" 20	17	" 8
6	" 24	12	" 18	18	" 25
				19	" 9

All of which is respectfully submitted.

S. F. PECKHAM,
Chemist to the Geological Survey of Minnesota.

St. Anthony's Falls, Dec. 23, 1873.

Of the foregoing samples analyzed by Prof. Peckham,

No. 1 was obtained at Stillwater, Washington county.
"A" was from Pleasant Grove, Olmsted county.
"Mineral Water" was from the reputed salt springs at Belle Plaine, Scott county. Other samples have been since obtained and will receive analysis.
No. 29 was from the sandstone near the Red Jacket Mills, in Blue Earth county, apparently consisting of magnesia or magnesia and lime. (See description of that locality, page 96.)
Nos. 30 and 31 were from the St. Lawrence limestone, the former from St. Lawrence, Scott county, the latter from Judson, in Blue Earth county.
No. 16 was a peat from St. Cloud, 18 inches below the surface.
No. 17 was a peat from Lura, in Faribault county, 18 inches below the surface; land of W. Z. Haight. Bog A.
No. 18 was from the same bog as No. 17, 3 feet below the surface.
No. 19 was a peat from the same place, Bog B, 18 in. below the surface.
No. 20 was from the same bog as No. 19, 3 feet below the surface.
No. 21 was a turf-peat, owned by John Haggard, Sec. 4, T. 101, R. 39.
No. 22 was from K. K. Peck's land, near Windom, 2 ft. below the surface.
No. 23 was from K. K. Peck's land, near Windom, 3 ft. below the surface.
No. 24 was a peat from land of Rev. Edward Savage, near Windom, 18 inches below the surface.
No. 25 was a turf-peat from S. O. Taggart's land, Sec. 24, T. 105, R. 35.
No. 26 was a peat from land of A. A. Soule, Mountain Lake, 2 feet below the surface.
No. 27 was peat from land of St. Paul & Sioux City Railroad, Sec. 13, T. 106, R. 37, 2 feet below the surface.
No. 28 was a peat from land of F. G. Taylor, Brooklyn, Hennepin Co.

(f) *Where Peat exists in Minnesota.*

The method adopted for testing for peat is very simple. A common auger, of about one and a half inch bore, is supplied with a jointed rod eight or ten feet in length. The handle and all of the joints are removable, and can be transported in one package. The thread of the auger will bring out the material passed through, from any desired depth, the samples being preserved if necessary. This will answer for most cases. If the peat prove too pulpy or too wet to be brought out on the thread of the auger, other means must be adopted. When it is too fibrous and loose to be penetrated by the auger, the desired sample can be taken out by the hand, as the loose and fibrous parts are always near the surface. The best way to illustrate the contents of a peat marsh, is to take out and dry a full section from the surface to the bottom, cutting the fiber with the slane, and exposing the variations in composition and color without disarranging their superposition.

The following notes on the observed location of peat deposits do not embrace a much larger class of observations, made during the summer on localities where peat does not exist, but where it was supposed by the owners to exist in abundance.

1. At a point about half a mile east of Empire City, in Dakota county, the auger was sunk in the land of Albert Whittier. This is within the valley of the Vermilion River, and revealed the following section:

No. 1.—Turf-peat, about	1 ft.
No. 2.—Black, sticky, heavy mud	3 ft.
No. 3.—Sand, with some gravel, penetrated	1 ft.

This character of surface prevails, judging from outward appearances, over an area of many acres in this part of the valley, passing also on to the land of Mr. Gray, further east.

2. Sec. 22, T. 114, R. 19, Dakota county. Owner's name unknown. Agents, Claggett & Crosby, Farmington.

No. 1.—Wet turf-peat	1 ft.
No. 2.—Fine, black mud	2 ft.
No. 3.—Green, sandy clay	1 ft.
No. 4.—Sand, of a greenish cast	2 ft. 4 in.
No. 5.—The same, indefinitely.	

3. About Sec. 22, T. 114, R. 19, Dakota county.

No. 1.—Black turf-peat, loose and fibrous..... 1 ft.
No. 2.—Fine, black mud..... 6 in.
No. 3.—Sand and gravel..... 6 in.
No. 4.—The same indifinitely.

4. In the same bog; near an outcrop of the St. Peter, N. W. from Empire City.

No. 1.—Black turf, fibrous..... 1 ft.
No. 2.—Sand; the same indefinitely..... 1 ft.

5. In the same bog; owned here by James Murphy.

No. 1.—Black, impure turfy peat..... 1 ft.
No. 2.—Yellowish-green, sandy clay..... 1 ft.

This burned over more or less for some distance in various directions a few years ago, passing also on to the land of others. This whole slough is termed "meadow" by the owners, and furnishes annual crops of hay. In the dry months teams can be driven over it in most places. It is in the valley of the Vermilion, the greater part lying on the north side of the river.

6. Land of James Murphy, Sec. 15, T. 114, R. 19.

No. 1.—Turf-mold, or turf-peat, dry and hard enough for teams to pass over, little fibrous, burned over a few years ago..... 1 ft. 6 in.
No. 2.—Yellowish-green clay [See Dr. Rose's Analyses].. 6 in.

7. Near the center of the same bog, E. of Murphy's.

No. 1.—Black turf-peat, wet..... 6 in.
No. 2.—Clay and mud of brownish-ash color, with streaks of green..... 1 ft.

8. Land of Caleb Adams, same slough. One mile northwest of Empire City.

No. 1.—Fibrous turf-peat..... 1 ft. 6 in.
No. 2.—Sand, indefinitely.

This peat has as good (or better,) appearance as any yet seen on this marsh.

9. Land of D. S. Pitcher, two and a half miles east of Farmington. Sec. 27, T. 114, R. 19. A branch of the Vermilion valley, coming in from the southwest, consists now of a long, wide slough, having the surface characteristics of the valley of the Vermilion.

Tested no further.

Mr. Pitcher says this surface turf burned, in 1863, from July to December, making many "hog-wallows."

10. Kasota, LeSueur Co. This marsh is crossed by the Sioux City R. R. This point is on the east side of the R. R. six rods from the drift bluff.

No. 1.—Pretty good peat..... 8 in.
No. 2.—Black, sandy clay 2 ft.

The whole depth drilled showed frequent shells.

11. In the same marsh, on the west side of the R. R. fifteen rods from the drift bank.

No. 1.—Roots and stems of grass, with some peaty, vegetable decomposition..... 8 in.
No. 2.—Black, peaty mud, with a few fragments of shells and some sand..... 1 ft. 4 in.
No. 3.—Black or brown mud, with sand and fragments of shells..... 4 ft.

12. Head of Lake Emily, in Le Sueur county, near St. Peter. Land of Mr. French.

No. 1.—Roots, and soft, fibrous lake sediment..... 1 ft.
No. 2.—Peaty lake sediment, with little or no sand..... 1 ft. 6 in.
[See Dr. Rose's analyses.]
No. 3.—Peaty mud, with a little sand..... 1 ft.
No. 4.—Black, lake mud, sandy.....2 ft.

13. Wells, Faribault Co., land of Clark W. Thompson.

No. 1.—Watery, fibrous peat..... 4 ft.
No. 2.—Peaty mud, with shells and some sand..... 6 in.
No. 3.—Brownish mud and clay..... 6 in.

14. Wells, Faribault Co., land of Clark W. Thompson. Same slough as the last.

No. 1.—Good peat, showing some sand grains..... 6 ft.
No. 2.—Peaty mud and clay. [See Dr. Rose's analyses].. 6 in. to 1 ft.

15. Wells, Faribault Co., same slough.

No. 1.—Peat of good quality..... 5 ft.
No. 2.—Peaty mud..... 6 in.

16. There is a peat deposit of 80 or 100 acres near Lura, in Faribault county, Sec. 30, T. 104, R. 25. Land of H. F. Quinby and J. Robinson. Said to be four feet deep.

17. Peat is manufactured near Fairmount, in Martin county, by Mr. A. L. Ward.

18. Near Lura Station, in Faribault county, peat exists in considerable quantities, on land of W. Z. Haight. [See Prof. Peckham's analyses.]

19. Sec. 24, T. 105, R. 35; Cottonwood county. Land of S. O. Taggart. In a dry slough, covering many acres, the surface consists of a turf-peat, to the depth of about a foot, passing into black mud and sand. The very top is fibrous and even spongy.

20. Land of S. O. Taggart, 5 miles east of Windom. In a narrow spring ravine, where water stands or slowly runs throughout the year, and near its head, a thickness of a foot or more of turf-peat may be taken out over a space of a few rods square. It is thicker and better near the head of the ravine than at any other point, owing to the more constant protection of the grass and roots from the prairie fires.

21. Other similar peaty ravines occur on land of Miss Ellen Imus, near that of Mr. Taggart.

22. A mile and a half north-east of Cannon City, Rice county. Land of Wm. Dunn. A shaking bog of peat is said to occur on S.E. 1-4 Sec. 11, T. 110, R. 20.

23. Mountain Lake, Cottonwood Co. Near Mountain Lake Station, on land of A. A. Soule, a coarse turf-peat covers the surface of a dry slough to the depth of ten to eighteen inches. Near a spring along the side of this slough which is tributary to Mountain Lake the surface quakes, and the peat is thickest.

24. Around Mountain Lake the land is low, and is flooded in the wet season. This low land contains considerable peat for some distance out toward the lake. The surface shakes under the tread. It is covered in the summer with a tall grass, which much resembles the wild rice, yet the softest places, where the peat occurs purest, are furnished with a short grass. Peat here is two or more feet thick. The land examined is owned by A. A. Soule.

[See Prof. Peckham's analyses.]

25. Sec. 13, T. 106, R. 37, Amo, Cottonwood Co. A slough that shakes is in the valley that forms the prolongation of the Des Moines Valley northwestward above the great bend a few miles above Windom, and has a spongy

peat about two feet in thickness, with black mud below. It covers six or ten acres.

26. In the same prolongation of the Des Moines Valley, on K. K. Peck's land, two miles above the bend of the Des Moines, is a thickness of two or three feet of peat. This valley seems to hold about two feet of peat along a considerable area through the middle, and would supply a great quantity. It is not of a superior quality, but might be very useful to the settlers.

27. Sec. 2, T. 105, R. 38, Cottonwood Co., Government land. Side-hill peat occurs on a gentle slope over the space of a few rods, having a thickness of a foot and a half or two feet. Such peaty patches appear also on the opposite side of the main valley, arising from the issuing of springs that keep the surface moist, while the lower land in the same slough is dry and hard. This peat is not free from sand. It also smells strongly of sulphuretted hydrogen.

28. NE. ¼ Sec. 28, T. 105, R. 36, Cottonwood Co. Land of A. J. Hall. In a turfed ravine, where water stands or slowly oozes through the turf, sloping gently toward the Des Moines river, a turf peat may be taken out to the depth of a foot or twenty inches. The belt containing peat is from ten to twenty feet wide, and similar in its situation to that of Mr. S. O. Taggart, but more extensive. It shakes under the feet for three or four feet about, but a horse can walk safely over it in most places in the dry season. Indeed, it is mown for hay every year. An irony scum lies on the ground and on the grass stalks. The peat itself is a turf, but contains shells and some grit.

Another similar ravine is on the same claim. Numereus others might be located along the ravines that cross the Des Moines bluffs.

29. SW. ¼ Sec. 4, T. 104, R. 36. Delafield, Jackson county. Land of Rev. Edward Savage. A good moss peat occurs here in a slough, having an average thickness of two feet, over an area of ten acres or more. The slough is confined between bluffs that appear to be entirely composed of drift, and has a feeble drainage into a small lake (String Lakes). The surface is mostly covered with a short (blue joint?) grass, but also with chair-bottom rushes. Some patches also of *Typha latifolia* are seen. No horsetail rush appears. In passing over the surface of this marsh it quakes five or six feet around, and the auger hole is immediately filled with water to the top. Below eighteen inches (even sparingly in ten or twelve inches) shells begin to be rather

common, and the auger next brings up a black mud with many shells. The most of this peat is made up of the peat moss, though at a depth of a foot or eighteen inches it contains grass roots and other fiber.

30. NE. ¼ Sec. 30, T. 105, R. 36. Land of Arthur Johnson. Turf-peat occurs in a ravine, twenty feet over, where fuel can be taken out.

31. Land of Geo. C. Bush, Sec. 6, T. 105, R. 37, holds a peaty turf, in a dry slough near the mouth of a ravine, in considerable abundance. Sandy below.

32. T. 105, R. 38, Southbrook, Cottonwood county. Peat exists, according to Mr. John Crapsey, three miles north of Talcott Lake.

33. Land of the St. Paul & Sioux City and Sioux City & St. Paul R. R. Sec. 31, T. 105, R. 37, Jackson county. A thin deposit of about six inches of peat covers about half an acre, mostly under water. This is the only peat that can be found in the vicinity of Heron Lake.

34. Land of F. G. Taylor, Brooklyn, Hennepin county, seven miles north of Minneapolis, furnishes a fine quality of peat. [See analyses of Prof. Peckham.]

35. Land of B. S. Langdon, Sec. 4, T. 102, R. 41, Nobles county. Here a turf-peat occurs, about 14 inches in thickness, lying on a side-hill or gentle slope, having a springy character when trod on. It is underlain by a black mud, which has been mistaken for non-fibrous peat. Of the turf several cords (perhaps a hundred) have been taken off, preparatory to excavating the rich (?) peat below, when it was discovered that it would not burn, but when placed in the fire turned out hard and heavy like burned clay. The turf itself will make a fuel that will compare well with any turf-peat discovered.

36. Peat, eight or ten inches thick, exists on the railroad land, Sec. 27, T. 101, R. 40, Nobles county, of a turfy character, but good quality. It lies over an acre or two, but may be taken out probably in other places along the different creeks that unite here.

37. At Bigelow, in Nobles county, there is a considerable thickness, perhaps two feet, of half-carbonized, pulpy, vegetable silt, lying entirely below the water of a lake, made up of decaying sedges and grasses and their roots. It is torn in pieces by the waves in the lake, and gathers about the shores and under the bog-turf, driven most abundantly to the side that faces the prevailing winds. It is often intermixed with fine mud and shells, especially near the

bottom. It will probably furnish, if dry, a combustible material that would answer well for fuel, if it should prove obtainable in sufficient quantities, and especially if it were to be pressed and molded. It has not the necessary origin nor nature to be styled peat.

38. John Haggard takes out turf in a low patch on Sec. 4, T. 101, R. 39, Nobles county. It occurs partly on State Swamp land, partly on railroad land, and partly on the claim of Charles Peterson. It is in nature and position similar to the turf on B. S. Langdon's land, northwest of Worthington. Mr. Haggard takes it out with a spade, about a foot in depth, in large blocks. Then drawing it to the house he cuts it into convenient smaller blocks, and spreads and piles it for drying. After drying about four or six weeks it is fit for burning. It burns quickly but leaves considerable ash. (See the report of Prof. S. F. Peckham.)

39. On the S.E. ¼ Sec. 27, T. 102, R. 34, Jackson county, Mr. W. V. King correctly describes a peat marsh.

40. Peat occurs of good quality just west of the limits of St. Cloud, in Stearns county, about a foot and a half thick, underlain by a bed of shell marl, which, before the introduction of the Shakopee lime, was considerably burned for quick lime. [See Prof. Peckham's analyses.]

41. Peat occurs within the corporate limits of St. Paul, having, according to Dr. C. D. Williams, a depth of eight feet. It lies on the land of Mr. Schmidt. [See analyses of Dr. Rose.]

42. At Red Wing, Goodhue county, good peat has been taken out, and experiments in manufacture made on the farm of Capt. O. Eames. This peat lies in the bottoms, between the shore and next range of river bluffs. The experiments were made under the direction of the Davidson Steamboat Company, by Capt. Isaac Webb, of Stillwater.

43. At East Minneapolis, Mr. W. W. Wales and Dr. M. D. Stoneman took out about 25 cords of peat in 1865. The average thickness is about eight feet, and the peat, although light and fibrous at the top, was heavy and solid below, becoming brown, or nearly black. Digging and drying cost 80 cents per cord. It was consumed in common stoves, leaving a heavy ash. In cost it could not compete with pine wood from the saw mills.

(g) *The working of Peat.*

The great porosity and consequent bulk of peat make it exceedingly desirable that, before it is used for fuel, it should be compressed, both for the purpose of removing the contained moisture, and of getting an intenser heat. The brown, fibrous peats are also liable to crumble on being handled, and will not bear transportation, unless rendered more tenacious and dense by some process of manufacture.

To accomplish this, various methods have been invented. The "turf" that is extensively burned by the peasantry in Ireland, France and Germany, is simply taken from the bog and dried in the sun. When first taken from the bog its weight consists of from 70 to 90 per cent. of water. When ready for use it still holds from 20 to 35 per cent. That which has been stacked from six to twelve months still retains from 18 to 20 per cent., and after being kept in a dry house for two years, from 10 to 15 per cent. of water. Its heating effect then is about equal to that of an equal weight of pine wood. Peat may be condensed and prepared by machinery so as to weigh more than hard wood. It may be made nearly as solid and tenacious as coal, its specific gravity being nearly that of bituminous coal. In this form it may be subjected to a strong blast, rendering it useful in ordinary grates and furnaces.

It is intended to dscribe briefly some of the methods of manufacturing peat in America. Many of the facts herein stated are obtained from *Leavitt's Peat Journal* of March, 1867; others from Prof. Johnson's "*Peat and its Uses.*"

"In this country comparatively little has been done; and, until quite recently, no machinery whatever, especially constructed and adapted for the production of solid fuel from peat, has been put in practical operation. The impression has seemed to prevail that the material is to be treated like clay, and that brick machines might be readily made to work the desired results; but the idea is erroneous. Numerous brick mahines have been tried, some of them very ingeniously and perfectly constructed, and which have been demonstrated to be almost perfect in their operation upon clay; but have proved an entire failure when peat was substituted instead. It is true, however, that with two or three of these machines peat has been compressed into compact blocks having the appearance of great solidity *when moist;* but so soon as the moisture is evaporated, as it will inevitably be in time, the mass is found to be porous and light.

"Quite a number of *presses*, some of them exceedingly ingenious in device and construction, and powerful in their operation and supposed to be so arranged as to press the water out of the mass, and leave the material compact and nearly or quite dry, have been built and tested, with failure of success as a uniform result; and although the records and reports of such cases, both in Europe and this country, are sufficiently extensive to explode the idea that any profitable results can be obtained by pressure alone, there are, nevertheless, those who are still persistent in their efforts to accomplish it by such means, and are now devising new methods of applying powerful pressure, which, were they to consider but for a moment the nature of the material in its crude state, would be seen at once to be clearly of no avail. The famous Beater Press, which, within a few years, has acquired great notoriety, and is now probably the most powerful press in use for hay, straw, cotton, tobacco, &c., has been tried several times in New York and Massachusetts, by parties sanguine of success, but with only the same results as with other presses."

Ashcroft and Betteley's Process.—"Under the patents of Ashcroft and Betteley operations were commenced in Massachusetts in 1864. Their process, as claimed, provides for separating the fibrous from the thoroughly decomposed portions of the peat, by combing; in doing which the mass is reduced to a pulp, which is then conveyed into high tanks where it is proposed to allow it to remain until by its own weight and pressure it shall have become sufficiently dense to be formed into blocks, when, by opening a small gate near the bottom of the tank, it is presumed that the pressure of the superincumbent mass will force it out in a continuous sheet, of uniform size, as regulated by the orifice, which may then be cut in blocks and laid away to dry."

Roberts' Process.—The machinery set up at Pekin, New York, in 1865, is the invention of Mr. M. S. Roberts. The following description of it is from the *Buffalo Express*, of November 17, 1865: "In outward form the machine was like a small frame house on wheels, supposing the smoke-stack to be a chimney. The engine and boiler are of locomotive style, the engine being of thirteen horse power. The principal features of the machine are a revolving elevator, and a conveyer. The elevator is seventy-five feet long, and runs from the top of the machine to the ground where the peat is dug up, placed on the elevator, carried to the top of the machine, and dropped into a revolving wheel that

cuts it up, separates from it all the coarse particles, bits of sticks, stones, etc., and throws them to one side. The peat is next dropped into a box below, where water is passed in sufficient to bring it to the consistency of mortar. By means of a slide under the control of the engineer, it is next sent to the rear of the machine, where the conveyer, one hundred feet long, takes it and carries it to within two rods of the end; at which point the peat begins to drop through to the ground to the depth of about four or five inches. When sufficient has passed through to cover the ground to the end of the conveyer—two rods—the conveyer is swung round about two feet, and the same process gone through as fast as the ground under the elevator, for the distance of two rods in length, and two feet in width, gets covered, the elevator being moved. After the eighteen rods are covered, the machine is moved two rods ahead, enabling it to again spread a semi-circular space of some thirty-two feet in width by eighteen rods in length. The same power which drives the engine moves the machine. It is estimated by Mr. Roberts that by the use of this machine from twenty to thirty tons of peat can be turned out in a day." Four men are required to run it.

In this process, it is to be observed that the method requires the addition of a very considerable quantity of water, before the peat can be treated; whereas a great desideratum has ever been to discover some process by which the large amount of water the peat already contains in its natural state, may be discharged.

Hodges' Process.—Mr. James Hodges, of Montreal, after considering the many difficulties in the way of manufacturing peat successfully, conceived the idea of a manufactory complete, which might be made to float about in the bog, excavating, pulping, manufacturing and spreading out the pulped peat to dry, until some seventy per cent. was evaporated, or it was fit for carriage to the store or to market. After three years' experience, he arrived at the conclusion that it may be effected in the following manner:

"An extensive, undrained bog, from eight to twelve feet in depth—or if deeper the better—having been selected, the first process is to trace out at some distance from the margin, a contour level line of say several miles in extent. Along this line, a space of some nineteen feet in width must be cleared and the live moss or turf entirely removed; by the side of this a space of ninety feet in width is to be cleared and drained to receive the pulped peat.

"At one end of the contour line before mentioned, a barge or scow, eighty feet long, sixteen feet beam and six feet deep, must be constructed, and launched into a hole in the bog dug to receive her. The barge or scow is to contain all the machinery necessary for the complete manufacture of the peat.

"At one end of the scow is placed a pair of large screw augers, eleven feet in diameter, which, being provided with proper shafting and gearing, are made to revolve by means of a steam engine placed on the rear of the vessel. These augers, or screw excavators, bore out the peat in precisely the same manner that a common auger bores itself into wood; and, the scow being made to move onward as the boring proceeds, it follows that a channel nineteen feet wide, of from four to six feet deep is formed, in which the scow, with her burden of machinery, floats, the water from the adjacent peat draining into and filling the canal as fast as it is made, the usual speed of the scow being some fifteen feet per hour.

"A competent engineer should determine and lay out the canal level, as well as arrange its water supply, upon which depends in a great measure the successful working of the whole.

"The peat, when bored out or excavated by the screws, is delivered into the barge, and conveyed by means of an elevator to a hopper, into which it is tumbled. It then passes through machinery which removes all sticks and roots, and, eventually destroying the fibre, reduces the peat to a homogeneous mass of soft pulp, like well tempered mortar.

"This pulp then passes into a long spout or distributor, which, extending at right angles over the side of the scow, spreads out the pulp on the leveled moss by the side of the canal in a thin slab nine inches in thickness and ninety feet in width.

"After the slab of pulp has been deposited for a couple of days, or in hot weather for a shorter period, it begins to consolidate, and shows symptoms of cracking. Immediately any cracks make their appearance, it must be marked out by drawing a frame-work carrying curved knives placed six inches apart, across it. A few days more harden the pulp so that by the aid of boards a man can walk on it, and mark it longitudinally with cuts eighteen inches apart.

"In about a fortnight, the shrinkage of the pulp-slab causes the cuts made in it to open, and the whole presents

the appearance of an immense floor covered with bricks eighteen inches long by six inches wide. As soon as the bricks are sufficiently hard to bear handling, they are separated and "footed;" that is, stood up on the ends, five in a stook, with one across the top, in which position they remain until dry enough to be removed to the store or to the market.

"In the manufacture of peat fuel considerable experience is required, and unless attention is paid to matters of detail, apparently of little importance, serious loss may be the result.

"In forming, or uncovering the canal track, nothing more is required than that the turf, or live moss, about six inches in thickness, together with the roots of all trees upon the surface of the bog, should be removed; and as upon all undrained bogs the roots of such stunted trees as grow there are all on the surface, this operation is easily accomplished.

"In the preparation of the pulp-beds great care is required, and a surface should be obtained as level and even as possible. The roots of all trees must be removed, and this is more readily accomplished with the trees themselves, by which means considerable labor is saved, one man pulling them down on one side, while another with an ax cuts the lateral roots at some distance from the stem, leaving the smaller portions behind. The long grass, shrubs and rank mosses are cut down with a short scythe, and used in filling up any irregularities in the surface. Drains from nine to twelve inches deep should also be cut and covered over with the spare turf taken from the canal track. The soil from the drains may also be used in leveling and filling up inequalities in the pulp-bed. In some places, where the growth of shrubs has been very rank and coarse, the turf upon the whole surface of the pulp-beds has been cut into strips and inverted; but it is better to cut drains, and leave the turf in its natural position. The soft pulp, when poured upon it in a semi-fluid state, advances lava-like, pressing down any small branches of shrubs and the long grasses which may be standing in the way of its onward progress.

"The pulp should not be deposited nearer than five feet of the canal, and upon this space may be placed any surplus moss or turf from the uncovering of the canal track, which will not only keep the pulp in place, but also form a road and towing path for the canal. At the rear, or ninety feet

from this bank, a double thickness of turf is all that is necessary to complete the pulp-beds.

"The canal track and pulp-beds being prepared, and the scow with its machinery in position, nothing more is required than to set it in motion, giving the necessary feed, say one and a half inches for each revolution of the screw excavators, which may be increased to three inches if necessary. As the screws revolve, they cut off continuous slices of the peat, which, by the assistance of a couple of men, are delivered, through the rear of the shield the screws work in, into a well in the bow of the scow. These men also remove any large masses of extraneous material, such as pieces of wood, roots of trees, etc., which may work in. It is sometimes required, when working in peat which is very full of roots, to have a man placed in front to remove them as they are brought up by the knives of the screws—roots as much as a man can lift being occasionally excavated.

"After the peat is delivered into the well, it is carried by means of an elevator, and tumbled into a hopper, from which it passes through the stick and fiber catcher, the pulping and distributing trough, without any assistance whatever; it being only necessary to see that the stick catcher is kept clear, and, occasionally, when the pulp is too dry, to turn on a pump until it is reduced to a proper consistency.

"The leveling of the pulp should be done as evenly and smoothly as possible. A few days' experience will enable any intelligent man to accomplish this; and upon its being well done depends, in some measure, the quality of skin upon the peat,—so essential, not only in shedding the rain and preventing cracking from the sun, but also in giving a permanent toughness to the bricks.

"The crew of the scow, all told, will number six, including the master who keeps the knives of the screw excavators clean, and sees that all is going on right: two men at the screw excavators, one engine man, one man leveling the pulp, and one man to tend the stick-catcher and pulping-spout.

"The marking of the pulp-beds into transverse cuts, at six inch intervals, is proceeded with as soon as the pulp begins to set, or becomes so tough that when the incisions or cuts are made in it by the knives, they do not re-unite. The operation is performed by two men, one on each side of the pulp-bed, who by means of a rope pull a frame-work of wood, carrying curved knives to and fro across the bed. A

little practice enables them to perform the work with great accuracy. The longitudinal cuts, eighteen inches apart, are made as soon as the pulp is sufficiently hard to bear the weight of a man upon a plank laid on its surface. It is performed by pushing a circular plate of iron, which, cutting like a circular saw, severs the peat to the very bottom. In making these last cuts, care should be taken that they go quite through the peat, so that surface water from rain may freely pass off through the drains in the pulp-beds into the canal.

"Upon the state of the weather depends the time when the next operation should be performed; but if the pulp-slab, when first spread out, is not more than nine inches in thickness, which it should never exceed, then a fortnight will be ample time to harden the bricks for footing.

"The footing is done by gangs of men and boys, one man and three boys working together; the man, using a suitable tool, separates the bricks, which the boys foot, or place in groups or stooks of five; four stand on their ends inclining to each other, with their tops touching, the fifth being balanced horizontally upon them. A man and three boys will foot four thousand bricks in a day.

"After the bricks have been exposed to the weather for a few days, they should be re-footed or turned, two boys handling four thousand as a day's work.

"Nothing now remains to be done but to wheel the bricks, when sufficiently dry, into barges, and convey them to the store."

Mr. Hodges' plan of operations is rather extensive, not to say immense, yet wherever the necessary area and supply of peat can be found, there can be no doubt but his method would prove as profitable as any other, and perhaps more so. It has been put into successful operation in Canada, and has furnished a fuel that, used on the Grand Trunk Railway, produced the most promising results.

Elsberg's Process.—This was invented by Dr. Louis Elsberg, of New York City, in 1864, and his experimental machinery was erected at Belleville, N. J. It is based on the principle of the *Exter process*, an invention made in Bavaria, in 1856. In the latter method the bog is laid dry by drains, and the bushes and grass turf removed down to good peat. A gang of three plows is then propelled by a portable steam engine over the surface tearing up the peat to the depth of about an inch. It is then pulverized where it lies by a harrow, drawn by oxen. After several turnings

by an instrument like our cultivator, in order to expose it to the air and sun, it is gathered by scrapers and loaded in wagons, and conveyed to the press or magazine, where it is further pulverized by passing it through a series of toothed rollers. It then enters a very complicated drying oven, where by a series of spiral rollers it is moved over successive shelves or floors, the interior of the oven being heated partly by steam and partly by hot air. The floors consist of steam-chambers, made of iron, and the hot air is made to circulate over the peat at a temperature of 120° to 140° Fah. The fine peat is thence conveyed to the press which forms it into bricks of suitable size for locomotives. It has a specific gravity of 1.14, and forms an excellent fuel. One cubic foot of this pressed peat weighs 72 pounds. The process of Elsberg varies from this in having a cylindrical pug-mill in which the peat, air-dried as in Exter's process, is further broken, and at the same time subjected to a current of steam admitted through a pipe and jacket surrounding the cylinder. The steamed peat is then condensed by presses similar to those of the Exter method, fed directly from the mill. In this way the complicated drying-oven of Exter is dispensed with. Samples of peat prepared by this method have, according to Prof. Johnson, a specific gravity of 1.2 to 1.3.

Leavitt's Process.—Mr. T. H. Leavitt, of Boston, Mass., in 1865 invented the following machinery and method of manufacturing peat: "The machinery consists of a strong tank or cistern, three feet in diameter, and six feet high, supported upon a stout framework about four feet above the floor of a suitable building, which should be near the bog, and is best constructed on a side-hill so that easy access can be had to the lower story on one side from the base of the hill, and to the second story on the other side. The top of this tank is open, and even with the floor of the second story. Within the tank, and firmly fixed to its sides, are numerous projections of a variety of forms, adapted to the treatment of the material in its several stages as it progresses through the mill, which is divided into three apartments; through the center of the tank revolves an upright shaft to which are affixed knived and arms varying in form and structure to correspond with the stationary projections in each apartment; below the tank is a receiver, or hopper; and under this is a moulding or forming machine, two feet in width and twelve feet long, of like simple construction, which receives the condensed material from the hopper and delivers it in blocks of any desired form and size. The whole

is adapted to be driven by a small steam engine and requires about six and ten horse-power respectively for the two sizes of machines as at present constructed, of the capacity of fifty and one hundred tons each of crude peat, per day of ten hours.

"The crude material is brought from the bog in ordinary horse carts, or on small cars running over a cheaply constructed tram-way, to the mouth of the mill, in the floor of the second story of the building, where it is dumped or shoveled into the mill in any convenient quantity; but the arrangement is such that only a given amount is admitted, and under treatment at any one time, so that all parts have a uniform and regular supply. The treatment is such that the original organization of the peat is entirely destroyed; in the second stage, the air, of which a large amount is contained in its cells, is ejected; advantage is taken of some of the natural properties of the material, and the mass is condensed in the moist state in the lower part of the mill, from whence it is delivered into the hopper of the moulding machine, and is discharged in a continuous line of moulds (which are fed into the rear part of the machine by a boy), at the rate of fifty to one hundred tons per day of ten hours. The work of removing the blocks to the spreading ground is easily accomplished; and they are exposed in the open air for drying, in much the same manner as bricks are exposed in a brick-yard.

"The amount of water contained in well drained peat is ordinarily from 65 to 75 per cent., varying according to the character of the material and the drainage of the meadow; so that the weight of dry, hard fuel from the product of a day's operations, is from 12 to 17 tons, or 25 to 35 tons, from the two sizes of machines respectively.

"The water remaining in the blocks as they come from the mill can be got rid of only by evaporation, which goes on very rapidly after this method of treatment; and the fuel is, at the expiration of about six to ten days, sometimes in four or five, in condition to be housed or transported to market."

The Rae Process.—This invention, patented May 22, 1866, was made by Dr. Julio H. Rae, of Syracuse, N. Y. It is thus described in a circular issued by the owners: "The peat is delivered into the top of a cylinder placed in a vertical position, in which is a revolving shaft, to which are permanently fastened, near its top, two or more arms, which are set at an angle with the axis of the shaft, their

office being to draw down the peat from the top of the cylinder and feed it along into that part of the cylinder where it will be subjected to the action of the revolving knives or cutters, which are found on the under side of the blades projecting from the shaft, and placed at an angle with the axis of the shaft. The number of blades can be varied, and also the number of cutters on the blades. In a cylinder of about four feet in length about seven such blades can be used advantageously. They are arranged around the shaft in spiral order, and are so inclined that the front edge of each blade is higher than the rear edge, whereby they are made to give a downward impulse to the peat as they revolve. Below the lowest blade is a propeller, consisting of a series of blades, each bent so as to form a section of a screw, but the blades are fastened to the shaft in the same plane. The office of the propeller is to seize the peat and press it downward through an opening in the bottom of the cylinder into a chamber, wherein are placed conveyors that convey and force the peat into condensing and discharging tubes that project through the sides of the chamber. The condensing tubes and the conveyors are placed in a horizontal position, the ends of the conveyors reaching a little way within the tubes, but they can be arranged in any other desired position. The inner ends of the tubes are cylindrical and the tubes gradually decrease in diameter for about one-half their length, so as to resemble the frustum of a cone. From or near the point of their greatest contraction, the tubes assume a shape nearly semi-cylindrical, retaining that shape to their outer ends, and gradually increasing again in diamter. The rounded upper side of the tubes at their discharge end, gives a corresponding rounded form to the peat that is forced through them, but any other form may be adopted. The peat is received from the ends of the discharging tubes on the ground or upon a traveling belt or platform, and may be cut up immediately into proper lengths, convenient to be handled in drying.

"There are four sizes of these machines, viz.:

"No. 1, requiring about one horse-power, designed for farmers, is capable of turning out per day what, when properly dried, will make from four to six tons of merchantable fuel.

"No 2 is double the capacity of No. 1, requiring about two horse power.

"No. 3 is a combination of Nos. 1 and 2, nearly double their capacity, requiring from four to six horse power.

"No. 4 is more than double the capacity of No. 3, requiring from eight to twelve horse power, and capable of turning out per day enough peat to make, when cured, forty tons of merchantable fuel."

These machines were run, a few years ago, by the Minnesota Peat Company, of St. Paul, and the Minnesota Packet Company. In simplicity of construction, and in power and capacity, these mills seem to excel. They also have a very great advantage over Leavitt's and all others employing moulds for giving shape to the condensed peat. The use of the moulds is cumbersome and expensive.

The Aubin Process.—This method was inaugurated at Meriden, Conn., in 1870. It covers different patents, designed for economizing labor, obtained in 1868 and 1869. The following description is from the circular issued by the agents in New York, in 1870: "If the manufacture of the fuel is to be carried on upon a limited scale, of say five tons, or thirty to fifty tons per day, hand labor, with the ordinary long-handled shovel, is probably the simplest and cheapest way to get the peat *up* from the deposit; it is then thrown into wheelbarrows, and if the distance be not too great, can be dumped directly into the mouth of the elevator. When peat to be dug is at a sufficient distance from the machine to justify or necessitate the use of cars, then a set of double portable rails can be employed. When the swamp cannot possibly be drained, the use of scows or wire tramways may be resorted to. For large operations, to supply railroads or manufacturing districts, a steam digger, on a scow, or on tracks, will be, of course, cheaper than hand-labor.

"The peat, once dug and conveyed from the pit, falls into a large hopper, from which a screw elevator, especially devised for peat, propels it up to the slicing and cleaning apparatus, placed above the grinding and puddling cylinder. When the bog cannot be drained, the peat taken from it contains, of course, too large a proportion of water for thorough and economical working; in such case the elevator is furnished with a *wringer*, which can be operated or not, at will, and arranged to separate the surplus water as the material passes through it. The peat, in a fit condition to work up well, being elevated in a continuous and evenly-fed supply, falls into the *slicer and cleaner*. This portion of the apparatus is composed of a series of rapidly revolving cutters, which, owing to their peculiar form and position, slice the peat and separate from it all hard or foreign substances.

From the slicer and cleaner the peat, *still better fitted* for grinding, falls into the *grinding and pulverizing* machine. This is a cylinder three feet in diameter by six feet long, and made of boiler-plate iron. The cylinder itself is stationary, but within is a large revolving iron drum, eighteen inches in diameter. To this are bolted in two spiral rows, forty-four cast iron knives, all nine inches long, but of three slightly varying shapes, and three sizes, increasing toward the mouth of the cylinder. These knives are named, according to size, *cutters*, *grinders* and *puddlers*, and remind one very much of the three kinds of teeth, incisors, canines and molars. They are between one and three inches in thickness and have each several square corners, but no sharp edges. Attached to the inside of the cylinder, under the drum, is a corresponding fixed series of twenty-two nearly crescent-shaped iron knives. Between these and the revolving knives the peat is carried along, cut, ground and perfectly "pulped," and falls, finally, into a sluggish stream, through a spout a foot or more square, into a large wooden moulding hopper. Along one side of the cylinder is the "stone pocket," a long, spacious iron trough, placed horizontally. It has an exterior cover for removing its contents, and communicates with the interior of the cylinder, to which it is attached in such a position that the revolving knives necessarily throw any stone or other hard substance into the pocket, instead of crushing it against the fixed knives. This contrivance is simple and effective. Under the moulding hopper is a series of rollers set in a long, stout frame, about four feet high and three feet wide, called the *conveyor*. One man puts a shallow wooden box or mould into a trough of water. Another submerges and removes it and lays it on a little branch of the conveyor. Here a wooden *pusher* strikes it a blow and sends it on the main conveyor; another drives it into the narrow space under the moulding hopper, where the weight of the peat and the hopper's peculiar shape fill it, before another blow from the same pusher forces a second mould under the hopper and expels the first. Other moulds rapidly follow, moving the first slowly along till a third pusher thrusts it upon a little side-shelf, from which two men easily set it down with eleven of its fellows, in three piles of four each, upon a wooden four-wheeled car.

"The drying field is a large, smooth meadow, crossed by two main tracks, running 1,500 feet in a straight line from the machine, and intersected at right angles by cross-tracks, 150 feet apart, and running 300 feet each way from the

main tracks, with turn-tables at the junctions. These tracks are three feet wide, and laid with iron rails near the machine, and wooden rails where the wear is less. There is a short switch-track, built so that three cars, instead of two, can be run up to the conveyor at once, though only one can be loaded at a time.

"The pulverized peat is so tenaciously adhesive that the moulds used are of a novel construction, to meet this difficulty. They are four and a half feet long by two feet wide, and five inches deep. The corners are secured with iron clamps, and an extra strip is nailed at each end to serve as a handle. The bottom is removeable, and across it are fastened, at equal distances, ten pine strips, about two and a half inches high and an inch wide at the base, but beveled off on each side to one-third that thickness at the top. These moulds cost about $2.50 each, and about 500 of them are in use.

"Each car is propelled by two men. Four men unload it. Two seize a mould, one at each end, walk briskly away with it to the place where it is to be dumped, tip it wrong side up, jerk off the side frame, and drop it on the grass, pick the bottom off the sticky mass of "pulp," toss it into the frame, catch up the empty mould again, and trot back to the car. This process is repeated with the other moulds. When first emptied, the wet, black peat is just dense enough to keep its shape; but in the warm season it hardens so fast that within forty-eight hours it will resist the severest storm, and then resume the drying process when the weather clears, at the point where the rain interrupted it. Strange as it may seem, this peat fuel absorbs much less water than wood does, and hence can be dried on the bare earth, under the open sky. It does not even adhere to the grass, which, however, is soon worn away.

"As it dries the peat shrinks to about half its first thickness, changes color from black to brown, and cracks along the grooves, so that when it is half dry, boys can easily 'hack' it—*i. e.*, break each mould into about twenty pieces, and pile it in two or three small, loose heaps. In two weeks or a month, according to the weather, the peat is dry enough to be gathered by men or boys, in baskets, barrows or carts, and stored in covered wooden sheds, with wide cracks between the sideboards to admit air, and the ends left open.

"The capacity of the three foot cylinder per day, at thirty revolutions regularly fed, is seventy-five tons of dry fuel.

Whatever be the number of revolutions, the moulding machine adapts itself to the demand.

"The cost of machinery, including *engine*, *boilers*, and entire equipment, is dependent on the amount of fuel it is required to be produced by the operator; being for small works, intended for horse-power—say five tons per day—about $200; for a product of 250 tons per day, about $20,000—an engine of eighty horse power being required to drive the latter."

Haight's Process.—This is the invention of Mr. W. Z. Haight, of Delavan, Faribault county, Minnesota. It has been successfully operated at Fairmont, in Martin county, and at Wells, in Faribault county. At the latter place it was taken for locomotives by the Southern Minnesota Railroad. The works at this place have been thus described by the Wells *Atlas:*

"A bold bank is selected, in order to secure a good drying yard close to the bog, on which the engine and machinery is located, where a frame is erected 12x16 feet and eight feet high, from the top of which a wooden car track, supported by a light trestle-work, descends to the surface of the bog, a distance of 150 feet, with a fall of 25 feet. From that point the track is made in sections of 14 feet each, which are portable, thrown down on the surface of the bog, and with the use of a few curved sections, the track can be shifted in any direction so as to excavate the entire bog that is in reach. This track can be extended many hundred feet out across the surface of the bog, if desired, giving access to several acres. On this track one car plies, which is loaded by three men who stand by the edge of the excavation, (water being lowered about six inches from the surface to insure dry feet). The sod is cut up into chunks, with sharp, diamond pointed, spade like tools, from two to four feet deep, according to depth of the peat, and left submerged in the water until the car is at the proper place, when the chunks are pitched from the water into the car, with common four-tined forks, and when the regular amount, about two tons, is loaded into the car, it is hauled by the power of the engine up the incline, over the large platform under which the mill is situated, and by a simple contrivance the car is made to dump its load, also to unship the windlass from the power that hauled it up, being no trouble to the feeder, who at will starts the car back, which, in going down the inclined plane gains momentum that carries it out hundreds of feet along the level track. Meanwhile the men in the bog do the necessary work, cut-

ting chunks for another load, so there is no time lost in the absence of the car. The feeder, who stands on the platform, then feeds the turfy mass into the mill, which is an ingeniously constructed machine, though simple, very durable, so arranged with knives cutting through grates, pickers, conveyers, &c., that it will treat the most fibrous mass or sod peat that can be produced and reduce it to a pulp or jelly at once, and that too without clogging or winding in the machine. Owing to its perfectness it renders it unnecessary to strip off the top sod from the bog, all that is necessary being to mow off the grass or other vegetation, if there is any growing thereon, thereby saving considerable expense in labor, also a good part of the fuel, when ground up with the lower or more decomposed peat. By the conveyers, the peat, as fast as pulped, is forced through a pipe into a vat with dump bottom, which holds one cart load. Here the cartman receives it by driving his cart under and dumping a load into it from the vat, adjusts the vat bottom, drives to the spreading ground, dumps his load from the cart and returns, during which time another load has accumulated in the vat. The pulp is dumped on a smooth plat of ground, where a man with a common shovel spreads it into beds four inches thick, nine feet wide, and as long as necessary, setting up boards at the sides to keep it from spreading, who is followed by another man with a tool similar to a rolling colter for a plow, fixed on a long handle, who cuts the bed of soft peat into blocks 8x13 inches, which commence to solidify at once by the ejection of the water, and in one or two days, by the use of a light tool made expressly for the purpose, these blocks are tipped up on edge or corners promiscuously, so the sun and wind can have a better chance at them. In two days more they are piled in open ricks, in which posture they remain on an average, two weeks, when they are housed to finish drying.

"The cost, the past season, of running this establishment, at a capacity of 60 tons of wet or 15 tons of dry peat per day, (equal at least, when properly prepared and well seasoned, to 15 cords of good wood,) is as follows:

Superintendent	$2 50
Engineer per day	2 75
Three men in bog to load car	6 00
Man to spread pulped peat into beds	1 50
Boy to turn up blocks	1 00
Two boys to rick up blocks	2 00
Man to feed peat into mill	1 50
Boy to drive cart	1 00

Man to cut peat into blocks	1 50
Cart horse	1 00
One ton peat at cost price for engine	1 72
For oil, and wear and tear on engine	1 00
Add 22 cts. per ton for housing 15 tons, one day's product	3 30
Total	$26 77

"All the peat is being sold at $4.00 a ton, except that to the Railroad Co., at which price the yield per day would be $60.00. Subtract from that the amount of expenses, $26.77, leaves $33.23—a handsome profit. The price of peat per ton should be estimated equal to that of good wood per cord, sawed and split for stove fuel, and unsawed for steam powers.

"The cost of an establishment, excepting engine and dry ing sheds, capable of manufacturing 100 tons of wet peat, or 25 tons when dry, per day,—Mill $400. Frame, trestle-work, car track, car, dump cart, &c., about $300.

"This is the cheapest mode of utilizing the peat, both as to the matter of machinery and labor, that we have any account of, and as it has been practically proven a success at this place, we see no reason, if the the same plan be followed, why it should not be equally successful elsewhere."

It must be admitted, however, that although great progress has been made in this country in the construction of machinery for the manufacture of peat, a great deal of labor and capital have been consumed to no purpose. Many of the companies that with hundreds of thousands of capital each, sprang into existence a few years ago when a feverish excitement spread over the country in reference to peat, have entirely disappeared, and nothing remains to witness their folly but the idle and rusty machinery they "invented" or purchased, and the almost forgotten titles to thousands of bogs, which they eagerly bought. This phase of the peat enterprise is not, however, the just criterion by which to judge of it. It is only an index of a deep seated want. The unmatured developments of the first peat agitators in this country were enough to start into a flame the desire of the people for relief from the high prices of wood and coal. The result was a wide-spread speculation. From this there has been a corresponding reaction. This however does not in the least affect the real value of peat as a fuel, nor detract from the credit of the inventions that have been made. Sober-minded men, consumers of large quantities of fuel, have in some instances, and in various parts of the country, steadily and persistently followed up the matter. Here and

there a railroad, an iron-furnace, a manufacturing establishment or a family has continued to produce and use peat fuel until it has won much of its lost favor, and is now in actual demand by consumers of the heaviest class, who are ready to purchase largely and at highly renumerative prices. This demand however is one that will not be met by anything less than a constant and steady supply, equal to its requirements. It calls for the best machinery, equipped with the best facilities and aids, and backed by large capital. The following extract is from a letter to the writer from T. H. Leavitt, of Boston, dated Dec. 3, 1873:

"The most active and really practical operations in peat and its utilization of which I have present knowledge are in the Lake Superior iron regions of Michigan.

"In October last I made a trip there and at Ishpeming, near Marquette, witnessed the successful use of peat fuel for the smelting of the ores of that region. Operations more or less experimental have been quietly prosecuted there during the last four years. A furnace of moderate capacity, especially adapted for smelting with peat, has recently been constructed and was put in operation about ten days before I was there, and was then in most perfect operation, and was considered a decided success as regards economy, ease of management, quality and quantity of metal produced, &c.

"The fuel was very poorly made, (lacking the density which might easily be given it, weighing 35 lbs. per bushel, whereas it might probably be made to weigh 40, 45 to 50 lbs. at no greater cost,) and in many things they lacked experience, but all appeared enthusiastic of their success. They commenced with charcoal and ten per cent. peat, gradually increasing until at the time I was there they were using upwards of 70 per cent. of peat, and were only waiting permission from the agent to use *all* peat, which the furnace men assured me they were convinced would be not only successfully done, but be actually better than to use any mixture of charcoal. The metal produced was regarded as fully equal in quality and perhaps superior to the very best grade ever produced in that region.

"Considering the immense quantities of peat in that region and the success attained with a fuel so poorly manufactured, I can but feel that for that region and its iron interests the peat-fuel enterprize has yet a prominent and very important place to fill.

"The cost of producing the fuel there is stated to be $3 per ton."

(h) *The Value of Peat for Fuel.*

It is not intended here to attempt the details of experiments and comparisons with the view of demonstrating the usefulness of peat as a fuel for domestic and metallurgical purposes. That has already been abundantly attested by the approval of railroad engineers, who have used it, and are still using it, both in this country and in Europe, and of owners of furnaces and manufacturing establishments, as well as by the testimony of chemists and government commissioners that have reported on its working, in France, in Germany and in America. The following tabulated comparisons are given for the purpose of placing within reach of those within the State interested in this subject, reliable means of estimating the cost of peat, and its heating capacity, compared with other kinds of fuel. These are the results of careful and long-continued experimentation:

(1) *Weight for weight.*

The following comparisons are given by Gysser, on certain woods and charcoals in Germany, the basis being equal weights of each.*

Beech wood, split, air-dried	1.00
Peat, condensed by Weber and Gysser's method, air-dried, with 25 per cent. of moisture	1.00
Peat, condensed by Weber and Gysser's method, hot-dried, with 10 per cent. moisture	1.48
Peat charcoal, from condensed peat	1.73
The same peat, simply cut and air dried	.80
Beech charcoal	1.90
Summer-oak wood	1.18
Birch wood	.95
White pine wood	.72
Alder	.65
Linden	.65
Red pine	.61
Poplar	.50

"The general results of the investigations hitherto made on all the common kinds of fuel, are given in the subjoined statement. The comparisons are made in units of heat, and refer to equal weights of the materials experimented with." [*Peat and its Uses*, p. 102.]

*See Prof. Johnson's "Peat and its Uses," p. 97.

Air-dry wood		2,800	
Air-dry peat	2,500		3,000
Perfectly dry wood		3,600	
Perfectly dry peat	3,000		4,000
Air-dry lignite, or brown coal	3,300		4,200
Perfectly dry lignite, or brown coal	4,000		5,000
Bituminous coal	3,800		7,000
Anthracite coal		7,500	
Wood charcoal	6,300		7,500
Coke	6,500		7,600

(2) *Bulk for bulk.*

One of the greatest obstacles to the general use of peat for fuel consists in its bulkiness. Uncondensed peat, air-dried, will occupy two and a half times the amount of storage room that anthracite coal will, the weights being equal. As it is also of lower heating capacity, requiring two and a quarter tons of peat to equal one of anthracite, the bulk required for the peat would be equal to five and five-eighths times that of coal. By condensation peat is greatly improved in heating capacity and in convenience of handling. Johnson gives the following as the composition and density of the best condensed peat, compared with that of hard wood and anthracite.

In 100 parts.	Carbon.	Hydrogen.	Oxygen and Nitrogen.	Ash.	Water.	Specific Gravity.
Wood	39.6	4.8	34.8	0.8	20.0	0.75
Condensed Peat	47.2	4.9	22.9	5.0	20.0	1.20
Anthracite	91.3	2.9	2.8	3.0		1.40

The heating power of peat, of the different qualities, taken from different depths, compared with pine wood, are thus given by Prof. Johnson, after Karmarsch, equal bulks being taken instead of equal weights:

100 cu. ft. of turfy peat,	on the average,	=	33	cu.	ft.	of pine wood in sticks	
"	fibrous	"	"	= 90	"	"	"
"	earthy	"	"	=145	"	"	"
"	pitchy	"	"	=184	"	"	"

The following also shows the relative heating effect and weights of an English cord of oak wood (taken at 100 as the standard) and of several European air-dried peats, bulk for bulk, quoted from Brix by Prof. Johnson:

	Weight per cord.	Heating Effect.
Oak wood	4,150 lbs.	100.
Peat from Linum, 1st quality, dense and pitchy	3,400 "	70.
" " 2nd quality, fibrous	2,900 "	55.
" " 3rd quality, turfy	2,270 "	53.
Peat from Buechsenfeld, 1st quality, hard and pitchy	3,400 "	74.
Peat from Buechsenfeld, 2nd quality	2,730 "	64.

(i) *What has been done in Peat.*

A few years ago the question of manufacturing peat was put to a practical test by the Minnesota Peat Company, located at St. Paul. The Rae machinery was used. The work was continued long enongh to show that it was not profitable at the current prices of wood, and was suspended. A similar attempt was made at Red Wing, about the same time, and with the same result. The process used there is not known. In Southern Minnesota Mr. W. Z. Haight has prosecuted the manufacture more successfully, and is now engaged in erecting the necessary buildings and apparatus for working peat by his process the coming season, at Lura Station, in Faribault county. He produced, at a cost of two dollars per ton, a good fuel at Wells, in the summer of 1871, with his machinery, which was well suited for use in locomotives. The stoppage of his work there was not due to a failure to produce a good fuel, nor to its being too costly, but, he says, to a lack of demand sufficiently large to warrant extensive operations. His method is described in a preceding section. Except the preparation of small amounts in St. Paul, by Dr. C. D. Williams, for experimentation, the foregoing are believed to be the only attempts that have ever been made in the State of Minnesota, to produce from the peat deposits of the State a fuel for general consumption by any process of manufacture.

(j) *Raw or Manufactured Peat.*

Some experiments have been made by Dr. C. D. Williams on a fuel made by a saturation of turf-peat with the residuum, or "shale oil," that is a product of the petroleum refineries of Pennsylvania. These trials demonstrate that a good fuel may thus be formed. The combustible material in the turf itself is not so much as in true peat. The analyses of Prof. Peckham show the greater per cent. of ash in excess of that of peat. This shale oil has a carbonaceous composition, not yet certainly ascertained, consisting very largely of carbon and hydrogen, both of which are combustible. The adding of the shale oil to the turf not only increases by so much the combustible material in a given bulk, but improves the quality of the fuel, By this means some of the poor peats may be made serviceable, at a cheaper rate, perhaps, than by the process of manufacture. The following facts in reference to the cost of this shale oil

delivered at Worthington, in Nobles county, are on the auhority of Dr. Williams. The residuum can be had for removing it from the vats:

Cost of barrel containing 43 to 45 gallons	$1 50
Cost of filling and drayage to cars, per barrel	50
Charges Pittsburgh, Fort Wayne & Chicago R. R. to Chicago	1 00
Charges West Wisconsin R. R. to St. Paul	1 00
Charges St. Paul & Sioux City R. R, to Worthington	1 00
Add for profits to dealer	1 00
Cost at Worthington per barrel	$6 00

(k) *Practical Conclusions on Peat.*

1. There is not so much real peat in the State of Minnesota as has been supposed. There is a great abundance of turf, made up of grass roots, containing a large per cent. of ash, not properly called peat, that will furnish, in any exigency, a fuel that will keep a family from suffering. This, however, it is not thought the object of the survey to investigate, nor to locate, as it exists, as is often stated in the public press, on almost every square mile.

2. While a good fuel, almost equal to the Iowa coal, can be produced by the manufacture of peat by a process of condensation and evaporation, it is far from certain that it will not cost as much, or more than wood or coal at the present prices.

3. If in any part of the northwest peat can be made useful as a fuel by manufacture, it is the woodless and coalless region of southern and western Minnesota.

4. Cautious experimentation should be carried on by those interested in the subject, with the view to test the comparative cost of peat, wood and coal, at the prices current in different localities.

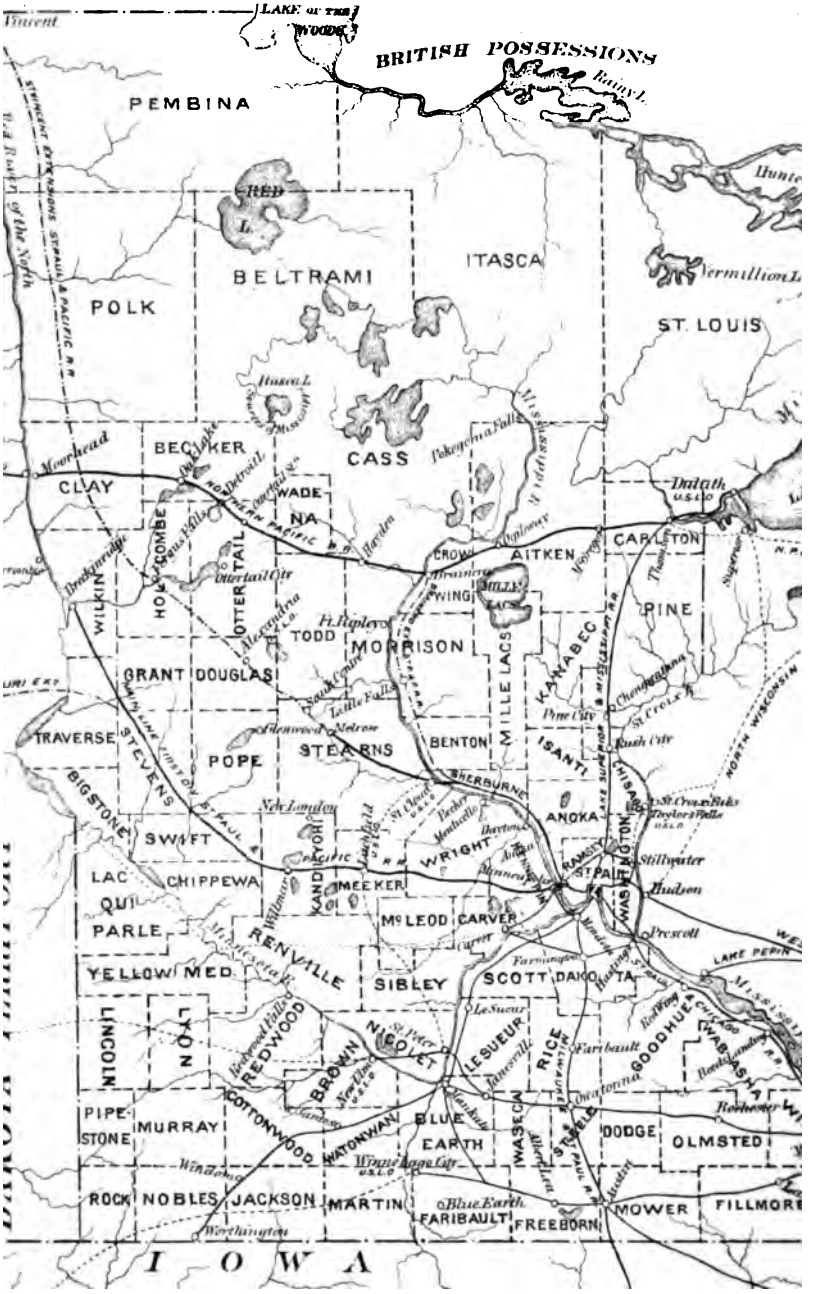
5. The farmers, and others who need fuel, but do not have means to produce a condensed peat, can take out in mid-summer a winter's supply, from the turf peat found on many farms in the prairie region, but they will generally not find it possible to utilize the real peat deposits without some method of manufacture. They will be too apt to crumble, and thus make a slow, smoldering fire.

6. There is no known instance of the existence of peat, in Minnesota along river valleys, on the bottom lands, where the surface is subject, at the present time, to inundation by spring freshets.

7. There are old river channels, or valleys of excavation,

Showing Location of the Counties.

Total area 83,531 square miles.



both in the drift and between rocky bluffs, that no longer exist as rivers, which contain considerable deposits of peat.

8. There are depressions in the rolling drift surface, in some localities, which, fed by invisible springs, maintain a nearly uniform stage of water throughout the year, and may hold peat of the best quality.

9. But a small portion of the State has been examined. In that a much smaller amount of peat was found than had been anticipated. Other portions, and especially the central southern counties, are believed to promise more peat than the counties examined. According to Dr. C. A. White, State Geologist of Iowa, a peat bearing belt enters Minnesota from the south, bounded, in general, by the Des Moines on the west, and the Cedar on the east.

10. Large quantities of peat are believed to exist in the northern part of the State, many of the cranberry marshes being peat bogs of great purity.

11. The value of peat as a common fuel having been demonstrated, and its existence in sufficient quantities within the State having been ascertained, it becomes a legitimate expedient for the State to stimulate the invention of successful methods of utilizing it by offering rewards.

III.

THE GEOLOGY OF THE MINNESOTA VALLEY.

(a) PRELIMINARY CONSIDERATIONS.

In the fall and winter of 1766 Jonathan Carver explored the valley of the Minnesota, but, aside from the mention of the rapids near Shakopee, he has given no information of the geology of the valley, although he claims to have ascended it a distance of two hundred miles above Mendota.[1]

The expedition of Maj. S. H. Long was undertaken in 1823, by order of John C. Calhoun, Secretary of War.

The able historiographer to the expedition was Wm. H. Keating, who also served as geologist. He was appointed from the University of Pennsylvania, where he occupied the chair of Mineralogy and Chemistry. This party ascended in canoes a distance of 130 miles, when they abandoned them for the land, following the valley to Big Stone Lake, thence descending the Red River valley to Lake Winnipeg. The observations of Prof. Keating on the geology of the Minnesota valley, are the earliest, with the exception of the doubtful accounts of Le Sueur, of the copper mines on the Blue Earth, that we have any knowledge of, although an old map accompanying the *Recueill de Voyages*, published in Amsterdam in 1720, shows a "coal mine" located some distance up the Minnesota. They were made with that haste which a traveling geologist always finds unavoidable when he is acting simply as an accompaniment to an expedition, instead of its guide and commander. No time could be spared to indulge the geologist in making such detailed observations as would enable him to state emphatically the bearings of isolated facts, which he picked up, on each other, or to generalize with any certainty. He could simply act as a gatherer of facts. His success lay in the exactness and fullness of his observations. Prof. Keating's geological observations may be summarized in the following descending section:

1. The bluff at Fort Snelling, made up of (a) slaty or splintery limestone, 8 feet; (b) blue limestone, useful for building, 15-20 feet; (c) sandstone, 60 feet; (d) earthy argillaceous limestone, 10 feet; (d) crystalline and conglomeritic limestone, 4 feet; (e) a limestone of finer grain and more earthy texture than the last, in which the river is excavated at the Fort. Keating is the only geologist that has ever reported limestone *in situ* below the sandstone (c) at Fort Snelling. Six miles below the small Indian village Weakaote, he notes the occurrence of the Little Rapids, caused by a sandstone in horizontal stratification "in every respect similar to that found at Fort St. Anthony." The same sandstone is again mentioned as occurring near Kasota, having horizontal ledges of rock overlying it, supposed to be the same as seen at Fort Snelling. The banks of the Redwood river, near its mouth, are said to be made up of "a fine white sandstone."
2. "Primitive rock" was first seen *in situ*, several miles above Patterson's Rapids, which are a few miles above the mouth of the Redwood river, and was examined very carefully and described in detail. He remarks in general: "It seemed as if four simple minerals, quartz, feldspar, mica and amphibole, had united here to produce almost all the varieties of combination which can arise from the association of two or more of these minerals." Owing to its confused and various composition, he compares it to that seen at a subsequent period of the expedition, between Lake Winnipeg and the Lake of the Woods. He regards all that section of country, between Patterson's Rapids and the Upper Mississippi, and thence

to Fort Alexander, at the mouth of Winnipeg river, as underlain by granite and sienitic granite. These rocks are again mentioned at a point five leagues above Lac qui Parle, at the mouth of Spirit Mountain Creek.

In the fall of 1835, G. W. Featherstonhaugh's ascent of the Minnesota occurred. His geological observations were very meagre. He took the pains to ascend the Blue Earth a short distance in search of the copper mine of Le Sueur. Keating did not visit it, passing it with the simple remark that he believed the substance obtained by Le Sueur to be a phosphate of iron, judging simply by its color. Mr. Featherstonhaugh says: "The Mahkatoh appears to form about half the volume of the St. Peter's, and is a ver yrapid stream. The Sissitons we had met, told us it forked eleven times, and that the branches abounded in rapids and shallow places. About twelve, we came to a fork or branch coming in on our right, about forty-five yards broad, and we turned into it, having a well wooded bluff on the right bank about ninety feet high. The stream had very little current, owing to the main branch, which we had just left, rushing down with great velocity and making back-water here. We had not proceeded three-quarters of a mile when we reached the place which the Sissitons had described to us as being that to which the Indians resorted for their pigment. This was a bluff about 150 feet high on the left bank, and from the slope being very much trodden and worn away, I saw at once that it was a locality which for some purpose or other had been frequented from a very remote period. We accordingly stopped there, and I told the men to make a fire and warm themselves, whilst I examined the place.

"As soon as I had reached that part of the bluff whence the pigment had been taken, Le Sueur's story lost all credit with me, for I instantly saw that it was nothing but a continuation of the seam which divided the limestone from the sandstone, and which I have before spoken of at the Myah Skah,* as containing a silicate of iron of bluish-green color. The concurrent account of all the Indians we had spoken with, that this was the place the aborigines had always resorted to to procure their pigment, and the total silence of everybody since Le Sueur's visit, respecting any deposit of copper ore in this or any other part of the country, convinced me that the story of his copper mines was a fabulous

*Myah Skah is "White Rock Bluff," supposed to be the bluff at Ottawa, in Le Sueur county.

one, most probably intended to raise himself in importance with the French government of that day. Charlevoix having stated that the mine was only a league and three-quarters from the mouth of the Terre Bleu, made it certain that I was now at that locality, and the seam of colored earth gave the key to the rest. Le Sueur's account of the mine being at the foot of a mountain ten leagues long, was as idle as the assertion that he had obtained 30,000 pounds of copper ore in twenty-two days, for there is nothing like a mountain in the neighborhood. The bluff, to be sure, rises to the height of about 150 feet from the river; but when you have ascended it you find yourself at the top of a level prairie, so that what might to an inexperienced traveler appear to be a mountainous height, is nothihg but the summit of the gorge which the river has cut out." [*Canoe Voyage up the Minnay Sotor, Vol.* 1, *p.* 303.]

With the exception of an occasional mention of granite in place, and a very brief notice of the red quartzite near the mouth of the Waraju river, the foregoing is the only geological note of importance recorded by Mr. Featherstonhaugh on the valley of the Minnesota.

In the survey of Wisconsin, Iowa and Minnesota by Dr. D. D. Owen, the examination of this river was committed to Dr. B. F. Shumard. Dr. Shumard and his party ascended the valley in canoes as far as the Redwood river, where he was attacked with pleurisy, and was compelled to abandon the further prosecution of the survey. This was in June, 1848. His report exhibits the first attempt ever made to parallelize the rocks of the valley with those of the rest of the state, and determine their geological age, and their equivalents in other states, by reference to a standard of comparison. That standard was a nomenclature adopted by the chief of the survey, based on the New York survey, as follows, with its equivalents:

No. 1. *Formation* 3, *C.* Coralline and Pentamerus beds of the Upper Magnesian Limestone. (The Niagara Group of New York.)
No. 2. *Formation* 3, *B.* Lead-bearing beds of the upper Magnesian Limestone. (The Utica Slate and Hudson River Group.)
No. 3. *Formation* 3, *A.* Shell-bed. (The Trenton and Black River Limestone, of New York.)
No. 4. *Formation* 2, *C.* Upper, white saccharoid sandstone, or St. Peter sandstone.
No. 5. *Formation* 2, *A. and B.* Low. Magnesian Limestone. (The Calciferous sandrock of New York.)
No. 6. *Formation* 1. Lower, light-colored quartzose sandstone. (The Potsdam sandstone of New York.)
No. 7. *Red, Argillaceous and Ferruginous sandstones.* (Supposed to be a downward extension of the Potsdam sandstone.)

Of these Dr. Shumard recognized Nos. 3 and 4 at the mouth of the river, in the Fort Snelling bluff. At Shakopee, and thence to the Little Rapids, he notes No. 5. The sandstone at the last place he regards as belonging to a formation several hundred feet below the white sandstone of No. 4, probably to No. 6. At "White Rock Bluff," situated on the right bank of the river, about six miles below Traverse des Sioux, he regards the exposed section to consist of No. 6, capped with No. 5, about fifty feet of the former and fifteen of the latter. The same formations are exposed, at intervals, to the mouth of the Blue Earth river, where the section is said to be similar to that of White Rock Bluff. Ascending the Blue Earth river six or eight miles and observing the same geological horizon as far as he went, he notes, subsequently, two or three exposures of No. 6 before reaching the mouth of the Waraju river, one being two miles below the mouth of that stream. The red quartzite at the mouth of the Waraju he regards as the lower beds of No. 6, more or less altered by metamorphism where they abut upon the igneous rocks. He also notes conglomerate and granite outcrops about a mile in a straight line above the mouth of the Waraju. He mentions granite at La Petite Roche, twenty-five miles above the mouth of the Waraju, and at frequent other points before reaching the Redwood. He describes an interesting exposure two or three miles below the mouth of this river.

There will be further occasion to refer to Dr. Shumard's report, since, although in the main corroborated by the observations of the past season, additional facts have been gathered which necessitate some change in his parallelisms.

(b) THE TRENTON LIMESTONE AND SHALES.

After leaving the immediate vicinity of the mouth of the river, this formation is not seen again throughout its course, consequently no new facts can be given respecting its characters or extent, except those noted in Dakota county.

The quarry of Daniel F. Aiken is a mile and a half northwest of Farmington, on Sec. 24, T. 114, R. 20. The beds show a considerable disturbance, and a portion of the usual building-stone, belonging to No. 4 of the section below, appears to be wanting from that cause. Yet Mr. Aiken is positive that no greater thickness of No. 4 exists there than that seen.

Section at Daniel F. Aiken's Quarry, near Farmington, Dakota Co.

No. 1.	Shattered, loose beds of limestone	5 feet.
No. 2.	Shale	6 "
No. 3.	Stone, which crumbles to shale	2 "
No. 4.	The Minneapolis quarry stone	4 "
	Total	17 feet.

In traveling south on the Sioux City Railroad, from Fort Snelling, the form of the brow of the bluffs of the Minnesota valley, appear to lose the Trenton on the east side of the river several miles sooner than on the west side. On the east side the limestone extends about three and a half or four miles above the fort. On the west side it seems to continue in the bluffs, though hid from sight, for a distance of six or eight miles.

(c) THE ST. PETER SANDSTONE.

This, like the Trenton overlying, also disappears from view soon after leaving Fort Snelling. Owing to its destructible nature, it is very rarely seen except when protected by the Trenton. Yet at one other point has it been discovered in the Minnesota valley. A very interesting observation was made at the Asylum quarry, at St. Peter, in Nicollet county. The stone there wrought is the first below the St. Peter Sandstone, the Shakopee limestone, the uppermost member of the Lower Magnesian. In the top of the quarry, where the workmen had stripped off the loose drift materials, about two feet of a white, friable sandstone were seen, with a thin strip of green shale about midway in it. This lay, in place, over the limestone, and afforded the only recorded observation ever made on the very base of the St. Peter Sandstone. It seems to maintain its strictly arenaceous character, or very nearly so, to its very contact with the limestone. This observation confirmed the belief, derived from the examination of the valley to that point, that the St. Peter and the Kasota quarries were in the same horizon as the Shakopee quarries, and that they all occur within the first thirty feet below the St. Peter Sandstone.

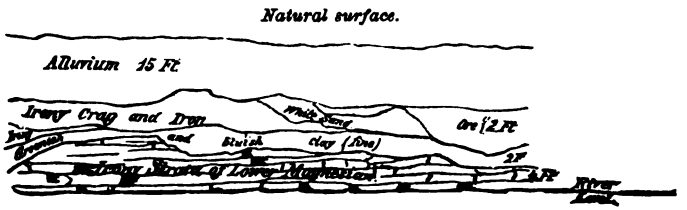
A friable, white sandstone, believed to be the St. Peter, was again observed, about two miles above the mouth of the Maple river, in the banks of which it affords a number of exposures. Those examined were in the northeastern part

of Rapidan township, in Blue Earth county, (T. 107, R. 27, Secs. 11, 12 and 13). It is here underlain by about two feet of a greenish-blue clay, and is associated with concretionary and irregular sheets of brown haematite. In the banks of the Maple, where the Shakopee limestone is exposed and somewhat quarried, there are occasional missing places in the beds of that formation. If by the action of the river the section is kept clear, so as to remove the drift, this bed of clay can be seen lying with distorted and dishing strata in these intervals. The strata are sometimes not preserved, but the masses appear as if thrust into the excavation in the Shakopee limestone, and are very sandy. In other cases the clay seems to have been shaped in layers conformable to the surface of the Lower Magnesian, but unconformable with its bedding. At one place the following section can be made out:

Section in Rapidan, Blue Earth Co.

No. 1.	Alluvium	15 feet.
No. 2.	Irony crag and impure iron ore	2 "
No. 3.	Greenish bedded clay	2 "
No. 4.	Strata of Shakopee limestone, more or less stained and encrusted with iron	4 "
	Total	8 feet.

These parts are arranged, relatively to each other, according to the annexed diagram:



The white sand which here is supposed to belong to the St. Peter, but which may belong to the Cretaceous, is in some way associated with this iron ore. It seems to lie in patches, sometimes just below the iron, and in other places where the iron is wanting. It seems to lie above the clay or shale (No. 3 of the section), its position being the same as that seen at St. Peter.

At other places, a little above the point of the foregoing section, the iron and sand are found irregularly mingled,

the iron occurring in the form of concretionary sheets, at least in sheets that enclose cavities. As much as four feet of this sand can here be made out, but the clay layer cannot be seen.

At a point a few rods further up, this white sand can be seen in a bluff on the left bank of the river (probably on sec. 13,) rising 40 or 50 feet, its exact upward limit being hid by the drift. At the bottom of this bluff the Shakopee limestone is exposed in the form of a rounded, water-worn buttress, rising in a solid mass about twelve feet above the river. About this bare rock, which exposes not more than a square rod surface, or 200 square feet, are fallen pieces of the iron ore mentioned. The rock itself seems coated with thin layers of irony stone, which yet appear calcareous. No clay or shale, the equivalent of No. 3, of the last section, can be seen. Overlying this iron and mingled with it, is a deposit of white sand, rising, as already stated, about fifty feet. This sand is so incoherent that one cannot ascend it. It slides like drift sand, yet is perfectly homogeneous *as sand*, without any resemblance to any drift sand. It is purely white. It is mainly massive; yet irregular lines of sedimentation can be seen in it. Also variously arranged in it are little, thin deposits of shale which probably were green till faded and oxydized. These are sometimes an inch thick, but usually not more than one-fourth of an inch. They are in detached, lenticular patches, and not now plastic, but soapy. No fossils can be seen. It seems to lie *unconformably on the Lower Magnesian*, separated only by a thin bed of greenish-blue shale. (Compare *Geological Survey of Missouri*, 1855–71, *p.* 142.)

At a point a little further along, this sand is more persistent, and shows horizontal bedding, by reason of the manner of its falling down from the bluff. Beds 3-8 inches.

In the banks of the Watonwan, at Garden City, in Blue Earth county, are further exposures of the St. Peter, at least of the sandstone already mentioned in Rapidan on the Le Sueur. It is here associated with more or less clay, crag, and iron and lime cement. A heavy deposit of drift crag may be seen on E. T. Norton's place, and also on Elder A. Case's land, on the right bank, opposite Mr. Norton's. Under the crag is clean white sand. A little further up in the bluff is red and blue clay, belonging, undoubtedly, to the Cretaceous. This crag is sometimes made up of this white sand cemented, with little gravel, and seems then to be derived mainly from the St. Peter, more or less disturbed by drift

forces. It lies on Mr. Case's land, in a continuous layer along the bluff, and projects like a bed of rock, the incoherency of the underlying white sand causing it to crumble out. This is also shown on the north side of Mr. Case's land, along the bluff where the current of the river has kept the surface fresh. This sandstone is again exposed in the banks of the river about two miles above Garden City.

Further examination of the St. Peter was made in Dakota county. An outlier of the St. Peter, situated in Sec. 11, T. 144, N. 19 W., is known as *Lone Rock*, owing to its rising in the midst of a prairie and forming a very conspicuous object for a great many miles in all directions. From its summit, which is about a hundred feet higher than the surrounding prairie, can be seen toward the east, the crests of several other outliers of the same stone within a mile or two, one of which is known as Chimney rock, while still further east the eye looks upon the bluffs of the opposite side of the Mississippi. Toward the south the valley of the Vermillion spreads out in a broad basin. Farmington village is situated to the southwest, and the spacious grain elevator of the station of Rosemount is a conspicuous object toward the northwest. The country immediately surrounding is a treeless prairie, for the most part a level. In the midst of this flat these knobs of the St. Peter rise, forming knolls on which, when sufficiently turfed, two or three species of oak, and a variety of shrubs, maintain a stunted growth. In the rocky knoll named Lone Rock there is a marked dip of the

Lone Rock, Sec. 11, T. 144, R. 19, Dakota Co.

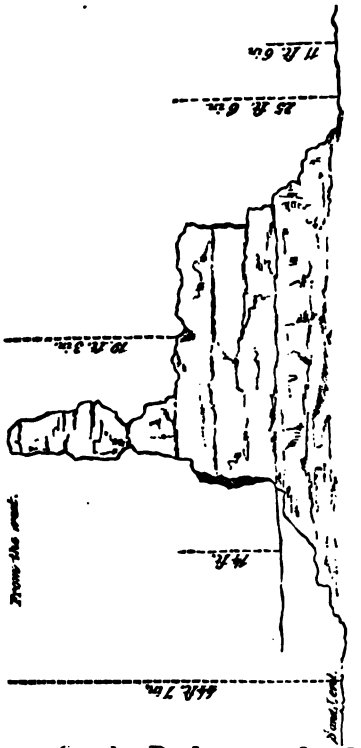


strata, 5 to 10 degrees, near the north end, toward the south; besides irregularities of sedimentation that greatly resemble dip. The rock rises in the form of an interrupted ridge, running north and south, and extends about twenty-five rods. The height from the surface of water standing in a little excavation on the northern flank of the bluff, to the base of the bare rock is 12 feet 4 inches, measured by Mr. Furber, by Locke's level; from the lowest rock seen to the top of the rock is 40 feet 11 inches, by the same. There are indications on the top of the rock that the formation did not extend much higher. The grains are coarser, and the lining cement is more abundant. The weather has also caused it near the top to show thin beds of one half to one and a half inches. The rock is about 20 feet wide at the northern end, but tapers to two or three feet; then swells out in a sort of zigzag ridge, and after one or two interruptions, disappears under turf on which grow shrubby oaks. The southern extremity is rocky again like the northern. The dip mentioned only shows at the northern extremity of the ridge. In the valleys about, the drift prevails, and boulders may be seen. The adjoining diagram shows the form and winding coutour of the ridge.

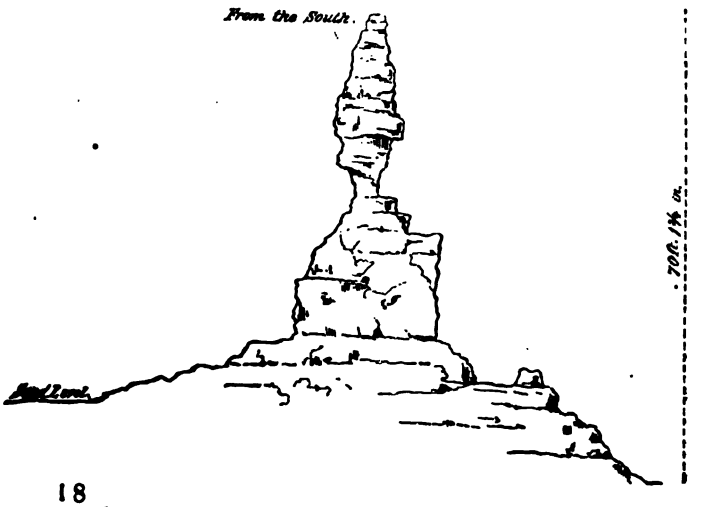
Another of these outliers is known as Castle Rock. It is situated in Sec. 32, T. 113 N., R. 19 W., Dakota county. The following diagrams show the elevation and aspect of this rock from the west, south and south east:*

* Featherstonhaugh gives a wood-cut of Castle Rock, drawn by a "traveller" who had visited it He locates it near the sources of Le Grand Gres river supposed to be Sand Creek.

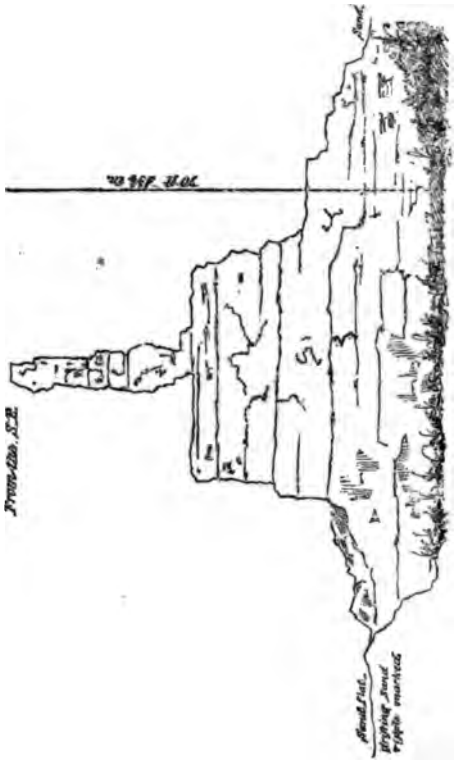
View of Castle Rock from the West.



View of Castle Rock from the South.



View of Castle Rock from the South-East.



There is another exposure of the St. Peter on Sec. 22, T. 114 N., R. 19 W., about a mile and a half west of Empire City, in Dakota county, within the river bluffs of the Vermilion, and on the north side of the immense slough that lies on that side of the river. It is somewhat quarried for foundation stone. The beds exposed are under about two feet of drift, and about twelve feet above the level of the slough. They lie horizontal. This indicates that the whole valley of the Vermilion, at that point, where it is said to have its greatest width, is wrought in that sandstone.

(d) THE SHAKOPEE LIMESTONE.

This limestone belongs to the great Lower Magnesian Formation, and is the uppermost member of it. In ascending the Minnesota valley its first outcrop is seen at Shako-

pee, in Scott county, where it is wrought for quicklime. It is again exposed at Louisville, in the same county, five miles above Shakopee. A short distance above Louisville it recedes from the river, and the underlying sandstone, seen at Jordan, comes to the surface with a gentle dip to the N. or N.E., forming the "Little Rapids" in the river, and affording a useful building-stone at the quarries at Jordan. In turn this sandstone, by the same dip, is driven back from the immediate valley, and a lower limestone is seen, as at St. Lawrence, having different physical characters, yet belonging to the great Lower Magnesian.

At Ottawa and Kasota, as also at St. Peter, the Shakopee limestone has returned. It thence continues in the valley of the Minnesota, sharing its banks with the underlying Jordan sandstone, to Mankato, where a fine exposure of the beds of both may be seen. As the river there changes its direction it soon passes away from the area of the Shakopee limestone, although there are several fine outcrops on the Blue Earth, and on its tributaries the LeSueur, the Cobb and the Maple, as far south as the township of Rapidan. It is also exposed on the Watonwan, at Garden City, and gives rise, as at other places in the same township, to valuable mill sites.

This, in general, is the course of the Shakopee limestone. It has formerly been supposed to represent the whole of the Lower Magnesian, or For. 2 of Dr. Owen. Its thickness is about 70 feet. The underlying sandstone is about 50 feet thick. The thickness of the next member of the Lower Magnesian has not yet been made out. It is visible at St. Lawrence, in Scott county, and at Judson, in Blue Earth county. This, it will be observed, is not in keeping with the age given the Jordan sandstone by Dr. B. F. Shumard. He referred the sandstone at Little Rapids, and that underlying the limestone at Mankato, to For. 1, of Dr. Owen's series, which he made the equivalent of the Potsdam, of New York. The Lower Magnesian, however, in the bluffs of the Mississippi, at Winona, and at other points, is over two hundred feet thick. In approaching St. Paul its thickness grows no less. It would be a singular phenomenon, to say the least, if at Shakopee, less than forty miles from Hastings where it has its full development, it should have become reduced to less than seventy-five feet. The existence of a heavy, calcareous formation below the Jordan sandstone, demonstrated by the observations of the past season, as detailed in the following pages, proves beyond all question

that the Jordan sandstone has been erroneously referred to the Potsdam age. The Shakopee limestone also maintains a distinct horizon in passing to the east. It was seen, in the season of 1872, at Quincy, in Olmsted county, and was mentioned in the report of progress for that year (page 82).

This assignment of the Jordan sandstone to the great Lower Magnesian formation is, on the other hand, in harmony with the reports of the Missouri geologists who describe that formation as made up of a series of alternating, yet constant, calcareous and arenaceous members. To what extent the lower part of the Lower Magnesian may be thus subdivided, and whether it corresponds to any extent with the Missouri subdivisions, it is not now possible to say.

Section at Shakopee, in Scott County.

No. 1.	Can hardly be separated from the rest, but seems more shattered and thinner bedded. It also contains some chert. It is crystalline and porous, with no regularity of bedding	6–8 feet.
No. 2.	An irregular layer of sandstone, or of very sandy limestone, used for building stone, making some good faces; beds about 8 inches	2 feet.
No. 3.	Rather heavier beds of hard grey limestone, of a magnesian texture and feel. These beds are sometimes cracked and checked in all directions, and pass into fine-grained patches, and then thicken again. These thin beds are not infrequently wavy or contorted within the mass. Purgatories are also common in the face of the bluff through all the parts	10–12 ft.

Section at Louisville, Scott County.

The quarry of Mr. G. Baptiste Contre shows a much disturbed and shattered condition of the layers, with frequent green stains as if of carbonate of copper. No constant general section of the bedding can be given, but the lower eight or ten feet are of a reddish color and in heavier beds. This quarry shows very evidently the effect of volcanic upheaval or disturbance. In general it bears a close resemblance to the stone seen at Shakopee. Twenty feet, more or less, can be seen. The quarry is in a bluff or terrace, facing the river, yet is separated from the river by another terrace of the same hight, made of the same layers of rock, facing away from the river. This latter rises as an island, about 30 feet above the river bottom.

The same rock is more or less exposed in the road from Shakopee, for a mile, before reaching Louisville. At Shakopee—and the same is true most of the way to Louisville—

this limestone is the cause of a distinct terrace, which rises about 20 feet above the bottoms. On the surface of this terrace a great many boulders of northern origin, often remarkably large, are strewn, the close proximity of the rock preventing them from disappearing in the thin alluvium. As the direction of the river seems not to coincide with the direction of the strike of the limestone, it soon passes on to the belt of the sandstone seen in the Little Rapids, and at Jordon, the transition from the former stone to the latter being indicated by a change in the character of the river bluffs, and the terrace already mentioned. A short distance below the mouth of Sand Creek the limestone affords an exposure in the right bank of the river, while the creek itself is on the sandstone. The sandstone there is the only rock visible in the river, as far as to St. Lawrence, which is in T. 114, R. 24, Scott county. The limestone there exposed lies below the sandstone, and will be described in another place. With the exception of a slight exposure a mile or two below Belle Plaine, and another near Blakeley, the rock is not seen again on the east side until reaching White Rock Bluff, at Ottawa. On the west side, about a mile below the Jessenland Church, (Sec. 13, T. 113, R. 26) there is a low outcrop of the lower limestone in the river bottoms.

At Ottawa, in Le Sueur county, the Shakopee stone has fully returned, and affords a very fine outcrop, rising, with the underlying standstone, to the hight of about 70 feet above the river, and causing as at Shakopee a broad terrace, on which the village stands.

Sections at Ottawa, Le Sueur county. (a) Quarry of John P. Rinshed.

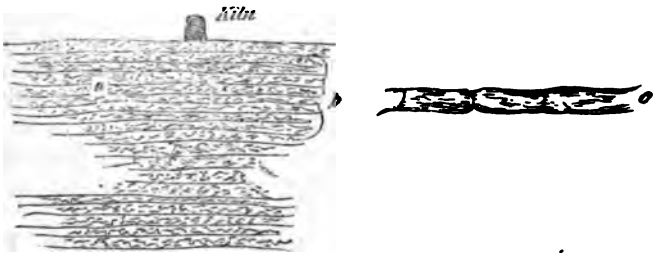
No. 1.	Fawn-colored, arenaceous limestone in even beds that correspond in undulations with the upper surface of No. 3.	4 ft.
No. 2.	Sandstone with a calcareous cement; of a lighter color, and corresponding in undulations with the surface of No. 3	2 ft.?
No. 3.	Magnesian limestone, very much like the Shakopee stone, holding green clayey deposits; in lenticular and irregular beds; the surface, freshly uncovered by the removal of the beds of No. 2, has much the appearance of being weathered, rising and falling at gradual angles and causing the overlying members to have corresponding undulations. Not well seen here. Said to be	8 ft.
	Total	14 ft.

Other quarries showing nearly the same composition of layers as Rinshed's, are owned by Levi Case and Charles Schwartz.

(*b*) *At Rinshed's Lime-kiln.*

Nearer the river, at Rinshed's kiln, the underlying sandstone can be seen. In this section there is exhibited either a fault or an instance of unconformability in the bedding. The relation of the sandstone to the limestone may be best exhibited by the following diagram:

Diagram showing the relation of the Limestone to the Sandstone, at Ottawa, Le Sueur County.



Explanation.

a. Horizontal layers of white crumbling sandstone showing oblique sedimentation; sedimentation undisturbed, seen 25 feet.
b. Interval of ten feet hid by debris.
c. One bed of fawn-colored limestone, almost free from sand; lies below the stone of Rinshed's quarry, 2 feet.

About ten rods below this kiln, near another old kiln built by excavating in the sandstone along the bluff, the following section may be seen:

(*c*) *Ten rods below Rinshed's Lime-kiln.*

No. 1. Limestone, fawn-colored, in undulating beds; beds two or three inches or as thick as one or two feet, apparently disturbed..... 15 feet.
No. 2. Sandstone, as at Rinshed's kiln, undisturbed, seen..... 25 feet.

Just back from the bluff where the last section was taken, is the opening that furnishes stone for the kiln. The limestone here appears like that at the bluff.

The whole of these exposures make up, in general, one irregular stratum of limestone, with sandy patches and layers occurring indiscriminately, and should not be divided generally into different members. The sandstone underlying, however, has an uneven upper surface, due perhaps, to the violence of the latest sedimentation, instead of upheaval,

before the deposition of the limestone. There is no other way except that of supposing a fault, or an instance of unconformability within the Lower Magnesian, to account for the position of the heavy bed of limestone exposed so far below the top of the sandstone at Rinshed's kiln.

A little more than a quarter of a mile below Rinshed's kiln, a little ravine crosses the beds, showing the upper portion of the sandstone, as follows:

(d) *Section in the Sandstone at Ottawa.*

No. 1.	Red, hard sandstone, in one heavy bed, exactly like that in the cut on the Sioux City R.R. near Louisville.....	1 foot.
No. 2.	White sandrock, like that in the railroad cut near Louisville..... seen	2-3 feet.

The observations made at Ottawa throw much light on the relation of the limestone there with that at Shakopee, thus—

Shakopee limestone=Ottawa limestone.
Louisville kilns....=Ottawa kilns.
Jordan sandstone..=Ottawa sandstone.

At St. Peter the quarry near the Asylum exposes the uppermost layers of the Shakopee limestone. Owing to the work going on in the finishing of the Asylum building, a fine opportunity is here afforded for seeing these beds in their best estate. The beds are here very regular, differing very much from the thin and confused bedding at Shakopee, and in the deep openings they seem to be all very heavy. Indeed, in the face of the quarry the bedding can hardly be discovered. It seems almost massive. Yet on quarrying the stone it parts along certain horizontal planes that must be bedding planes. Some faces show five feet. Other beds are two, and three, and four feet. The upper four feet are checked into beds of two to four inches by the weather. It is rather darker, when first quarried, than the Kasota stone, but has the same general cast of color. It seems sometimes to have a brownish tinge. The amount seen here is about twenty-five feet.

In the banks of the river at St. Peter, the sandstone, corresponding to that already described at Ottawa, can be seen, forming perpendicular or overhanging bluffs fifteen feet or more in height.

On the terrace formed at St. Peter by these rocks, other

quarries have been opened by Albert Knight, and by others, but none exhibit the characters of the formation so fully as that at the Asylum.

Across the river from St. Peter, and about a mile toward Kasota, is another exposure of the limestone, in a bluff along the roadside. It seems here to be more shattered and irregular, and like the Shakopee stone. Lime burned near here cannot be distinguished from the Shakopee lime. About eighteen feet are seen, the lower part being in good heavy beds. The upper surface is waterworn, and in the openings the Cretaceous has been deposited.

Geo. C. Clapp's lime kiln and quarry are five miles below Mankato, on sec. 17, township of Kasota, within the main drift bluffs of the Minnesota, but on the terrace formed by the Shakopee limestone, and about a mile from the river. His quarry, located near his kiln, exposes a fine gray limestone, about two feet thick, sometimes less or more, graduating into the Shakopee stone which underlies. It is very firm, little porous, and contains *Orthis*, at least, and affords the finest and purest limestone hitherto seen in the Shakopee stone. It must be regarded as the upper portion of the Shakopee. This fine, compact texture, and gray color, are not continuous in the same horizon, in other places the harsh magnesian grain and arenaceous quality existing in the same beds. Running along the river for several miles, sometimes touching the river and sometimes exposed back of islands that show the same, this limestone forms a bluff of solid beds. Although there is usually a heavy talus covering the foot of this bluff, yet at several points the identity of this horizon with that at St. Peter, and hence with that at Shakopee, is fully established by the exposure of the underlying sandstone. It is seen at a point about two miles below Mr. Clapp's farm. This bluff shows a good stone, as at St. Peter and Kasota, but is not much quarried. Perhaps it is more arenaceous in patches. It is blotched with whiter spots, and with soft chert.

Another fine exposure of this geological horizon is visible about a mile and three quarters below Mankato, on the same side of the river. The place here referred to is that sometimes known as Hurricane Bend, although the point so named by steamboat captains is said to be about four miles further down the river. The section here exposed is the same as at Clapp's, and also the same as at Mankato, but here there is an observed thickness of sandstone amounting to forty-five feet, somewhat hid by debris. This equiv-

alency is unmistakable, since the bluff can be traced nearly all the way to Clapp's, and since between here and Mankato, besides the continuance of the same surface features—the wide, stony prairie formed by the terrace, the uniform altitude of the terrace, and its striking similarity to the terraces at St. Peter, Kasota, Ottawa and Shakopee—the actual continuity of the formation can almost be traced out by exposures of the rock.

In the report of progress for 1872, the section at Maxfield's quarry at Mankato was given, (p. 83,) covering 61 feet of the Shakopee limestone. The further examination of this locality, and of the river bluffs for several miles below, during the season of 1873, makes it desirable to unite the sections observed in one general section, as follows:

Section at Mankato, in Blue Earth County.

No. 1.	Porous magnesian limestone, not used	4–6 ft.
No. 2.	Coarse, friable sandstone	2–4 ft.
No. 3.	Magnesian limestone burned for lime	2 ft.
No. 4.	Calciferous sandstone, in heavy beds, of various grain and texture, sometimes mottled, quarried for building	30 ft.
No. 5.	Upper shale bed, arenaceous and mottled with red	2–3 ft.
No. 6.	Calciferous sandstone, generally used as a cut-stone, compact and even grained	4 ft.
No. 7.	Rough and irregular magnesian limestone, somewhat arenaceous, but unfit for cutting	10 ft.
No. 8.	Lower shale bed; very much the same as the upper	2 ft.
No. 9.	One heavy bed, generally good for cut-stone	3 ft.
No. 10.	Irregular and sandy bed; more or less cavernous and porous, its lower three or four inches in thin chips, fine grained, and stained with iron	3 ft.
No. 11.	Jordan sandstone, seen about	45 ft.
	Total of the Shakopee limestone, about	65 ft.

From Mankato toward the mouth of the Blue Earth river, the Shakopee limestone is seen at frequent places, forming precipitous mural faces, capping the underlying sandstone; the two united making bluffs that rise from seventy-five to a hundred feet. These exposures are mostly on the right bank, but there are also elevated islands in the river, or at least elevated portions in the area of the bottom land, that present similar perpendicular rocky bluffs on one or more sides. These exposures extend somewhat beyond the mouth of the Blue Earth. The Blue Earth has cut its passage through this rim of rock, at the point of its debouchure upon the Minnesota bottom land, and on its right bank, at the place of the crossing of the St. Paul and Sioux City R. R., a series of interesting observations were made. Before

reaching this point, however, in following the highway from Mankato to South Bend, but on the east side of the bridge over the Blue Earth, the Shakopee limestone is exposed in a recent excavation by the side of the road, in the removal of the Cretaceous clay, which is seen there to overlie it unconformably. The limestone here shows the effects of long exposure to the weather, and the action of water in the form of waves, probably those of the Cretaceous ocean, prior to the deposition of the clay. A much better example of the same effects may be seen a little further south, just before the crossing of the Blue Earth by the Sioux City R. R., where the grade is cut into the rock for several rods before reaching the river. The old Silurian surface is here very much weathered, and coated with iron peroxide, the nooks and openings, and all sheltered places being filled with the fine, plastic but bedded greenish clays of the Cretaceous age; the drift gravels and sands overlying both. These phenomena are alluded to again and more fully discussed under the head of the Cretaceous.

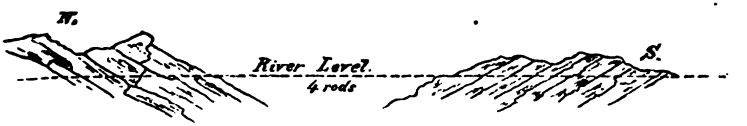
Passing from the mouth of the Blue Earth south, toward the Red Jacket Flouring Mills, occasional exposures of the Shakopee stone are met with along the highway and in the railroad cuts (Minn. and Northwestern R. R.), for about three miles. The Red Jacket Mills are on the Le Sueur river, four miles south of Mankato.

On the Maple, near its union with the Le Sueur, in sections 11, 12 and 13, township of Rapidan, (107, 27,) Blue Earth county, quarries that are feebly run, are owned by Barney Simmons, Samuel Michael, and by Messrs. Averill, Culver, Wood and Allgrain. These quarries reach about two miles above the mouth of the Maple, and are in the same horizon as the Mankato quarries. The stone occurs in horizontal, heavy beds, along the low banks of the river, exposing 25 or 30 feet. Some mention has been made of the Shakopee stone at this place in describing the sandstone there seen to overlie it, and supposed to be the St. Peter. (See p. 133).

The Shakopee limestone is exposed at Garden City, in Blue Earth county, in the banks of the Watonwan river. Mr. S. M. Folsom owns a slight exposure which is somewhat worked, situated in the low bank of the river, near the water. At the milldam, just above the highway bridge, it may be seen, exposed in a rough and very irregular outcrop, in the midst of the river, forming a rocky island. It here

presents large cavities, and sometimes a breccia. The beds are thick, and lie in a short synclinal, as illustrated below.

Synclinal in the Shakopee Limestone, at Garden City, in Blue Earth County.



This synclinal is not believed to be anything that affects the general dip of the formation, but an illustration of the irregularity that it sometimes presents in its bedding. A similar phenomenon was noted in respect to this limestone, at Ottawa, in LeSueur county. It is a structure very common in the Waterlime, of the Upper Silurian, seen in northwestern Ohio.

This exposure of the Shakopee limestone has very much the general character seen at Shakopee. In the roughened upper surface the usual gasteropod, seen also last year at Rochester, in Olmsted county, was seen at Garden city, (*Euomphalus.*)

(e) THE JORDAN SANDSTONE.

This name is here applied to that member of the Lower Magnesian which immediately underlies the Shakopee Limestone. As has already been stated, it has been referred by Dr. B. F. Shumard to the Potsdam Sandstone or Formation 1, of Dr. Owen's series. The observations of the past season have disclosed the fact that it is only about fifty feet in thickness, and is underlain by another great limestone formation which, while it differs considerably from the Shakopee stone, is still a magnesian limestone, and belongs to the same great series.

This stone is first seen in ascending the Minnesota valley, so far as at present known, at the "Little Rapids," near the city of Carver, in Carver county. It here causes a fall of about seven feet, divided between two separate rapids. The lower rapid has a fall of about four feet. The upper is about half a mile further up. The stone is thick bedded and coarse-grained. A few rods above the upper rapid it is exposed in the right bank, showing about six feet in nearly horizontal beds. This sandstone was penetrated in sinking

a well at Louisville, after passing through the Shakopee Limestone, the thickness of over twenty feet. Passing along the public road from Louisville to Jordan, the strike of the sandstone can be seen by outcrops, in the form of stony islands, in the river bottoms, and by exposures near Dooleyville. Where the public road crosses "Van Oser's"* creek, a short distance above Dooleyville, it has a dip of 10 or 15 degrees toward the W.N.W. About twenty-five feet can here be made out in passing along the stream from a short distance above the road to the crossing of the St. Paul and Sioux City R. R. It is in heavy beds and is coarse grained. It is full of seams and checks, presenting some appearance of dip in different directions. Some of the seams, or lines of apparent bedding, run nearly perpendicular, but they do not have a constancy that shows dip. The operation of the stream is such as to bring out the bedding, by the wearing away of the softer layers, so as to indicate dip in the direction already stated.

Near the railroad bridge over Van Oser's Creek, and in the public road, this sandstone is conglomeritic and broken. It shows the effect of heat. The bedding is disturbed and even fractured, the openings having been again filled with coarser materials and some pebbles. Some parts of it are highly ferruginous, so as to make an impure iron ore which is black. These characters, however, are confined to a very small area, not being seen over more than three or four square yards, making a mound-like prominence that rises two or three feet above the level of the rest of the bedding, which is bare for some rods about.

About a mile above the crossing of Van Oser's Creek, the St. Paul and Sioux City R. R. cuts through sandstone which may be somewhat below the beds last mentioned. The upper part of this may be regarded as belonging in the section at the creek. This cut is composed of the following parts:

No. 1.	Hard (yet within friable) sandstone, in one bed, of a reddish color, which resembles the color of the Shakopee stone near the bottom of the section at Louisville.....	8 ft.
No. 2.	Fine, incoherent, white sandrock, massive; seen five feet, may amount to.....	10 ft.

Directly east of this cut, across the public road, No. 1 above, which is supposed to be the same as the sandstone seen in Van Oser's creek, outcrops so as to show 15 or 20

* This is corrupted from Van Osterhaus.

feet. It causes a considerable knoll, where huge blocks four or five feet thick are checked loose by the weather and removed from the general mass. This is a favorable place for quarrying.

At Jordan, three and a half miles above this place, this sandstone affords its typical outcrop. It occurs in sand creek, about a half mile above the village. Quarries here are owned by John Volk, and by Wosanick and Loniacheck. The general section obtainable from the various outcrops along this creek has thus been described.*

Section at Jordan, Scott County.

No. 1.	Sandrock, buffish, quite ferruginous, thick-bedded, seen at the mill	6 feet.
No. 2.	Sandrock, ferruginous, thin and irregularly bedded, friable and disintegrating, with many ferruginous seams, crusts and concretions. In the quarry	3 feet.
No. 3.	Sandrock, irregularly whitish or ferruginous, heavy-bedded, obliquely and beautifully banded with iron streaks and laminae. In quarry	12 feet.
No. 4.	Sandrock, buffish, similar to No. 3, but thinner-bedded. In the quarry	8 feet.
No. 5.	Sandrock, hard and ferruginous above, soft, friable and buffish red below. Falls of Sand Creek	10 feet.
No. 6.	Sandrock, whitish, compact. In the beer vaults, seen	12 feet.

In the bed of the creek, near the breweries, this stone seems somewhat calcareous. It is of a reddish color and slightly porous, while the quarried stone shows generally a white color, except where irony water has rusted the interlaminations, presenting then a streaked section of rust and white. The bedding in the creek is also thinner. Although the foregoing section makes up a thickness of 51 feet for this sandstone as exposed at this place, the observations of the survey do not warrant the assignment of that aggregate thickness to the outcrops there. Some of the localities named being regarded as on the same geological horizon. The general uniformity of characters makes it difficult to judge how much of the bedding at one place may be included in the outcrop at another; but twenty-five or thirty feet would probably cover the thickness exposed.

The next known exposure of this stone is at Ottawa, where it underlies a considerable thickness of the Shakopee limestone. The geology of this place has been given in treating of the Shakopee Limestone. The interesting ob-

*Report of a geological survey of the vicinity of Belle Plaine, Scott Co., Minn. By Alexander Winchell. In this report the name of *Jordan sandstone* was first applied to this stone, although still regarded as of the Potsdam age.

servation was there made of a local unconformability in the limestone, with the Jordan sandstone. (See p. 141.)

From Ottawa to Mankato, this sandstone may be seen at nearly all places where the Shakopee limestone is exposed. It is apt to be somewhat covered by debris, as it lies at the base of the continuous bluffs that these two formations cause throughout that part of the Minnesota valley.

Near the Red Jacket Mills, four miles south of Mankato, on the Le Sueur, is an outcrop of sandstone, which is doubtfully referred to the Jordan. It is in the right bank, just above the mill dam. It forms a perpendicular bluff rising from the water about 20 feet, underlying a heavy deposit of drift which rises nearly two hundred feet higher. In the sandstone are soft, apparently magnesio-calcareous pieces, about an inch in diameter, usually flattened, or pointed, or edged, which if dry, crumble to powder in the fingers, revealing little or no grit, but which when wet, are sticky and plastic. These pieces resemble somewhat the thin deposits of shale seen in the sandstone that has been referred to the St. Peter a few miles higher up on the Le Sueur. (See the Report of Prof. Peckham for an analysis of these pieces of shale.) This fact, in connection with the existence of irony crag in the overlying drift bluff, makes the resemblance of this outcrop to the above outcrops supposed to be St. Peter, and to those at Garden City, rather greater than to the Jordan. The geographical and topographical relations of this outcrop, however, cause it to appear very strongly to belong to the Jordan. (See p. 133.)

At Cappels mill, on the Watonwan, two and a half miles below Garden City, a sandstone is exposed, and somewhat worked. Its stratigraphical relations are not certain, but it probably belongs to the Jordan.

Three miles below is the Rapidan mill. The same sandstone is exposed at this mill and at several places between these mills.

At Minneopa Falls, sec. 21, T. 108, R. 27, the cascade is caused by the Jordan sandstone. The perpendicular fall of the water is about 30 feet, but 45 feet of the sandstone can be made out. Before reaching the point where the water leaps over, the stream works its way through a perpendicular thickness of 15 feet of sandstone beds. It then comes in contact with a harder portion of the sandstone, which has a thickness of about six feet. This resists the water longer than the underlying layers, and maintains a projecting shelf. The mist that rises keeps the walls wet, and the freezing of

winter crumbles away the soft sandstone, so as to form about the pool where the water strikes, a walled amphitheater rising about 40 feet on each side. This glen is more or less shaded with elms, cedars, birches, butternuts and oaks. It is prolonged in the form of a rough and shaded gorge, worn in the solid rock, of about the same depth, down to the point of issue of the stream upon the Minnesota bottoms, the distance of about half a mile. The gorge below the fall is darkened by the dense foliage, the stream in its course being much of the time hid from sight but for a few rods. This gorge is crossed, about a quarter of a mile below the falls, by the St. Paul and Sioux City R. R. At the foot of the falls a little lake of water is confined by the upheaved pebbles in front of the cascade. The gravel of the surrounding beach is hard enough to admit of a passage on all sides. There are also several narrow paths along the walls of the amphitheater, where the fallen fragments are sufficiently turfed and overgrown to permit a passage up or down the stream. An elm tree which is nearly three feet in diameter grows near the foot of the cascade, and on the right bank. Its annual rings of growth would indicate at least some part of the time elapsed since the retreat of the fall from the place where it stands. Within six feet of it the perpendicular sandstone wall rises to the hight of over forty feet. The stream is subject to great fluctuations of volume, sometimes becoming quite dry. In passing down the Minneopa gorge to its union with the Minnesota river, the bluffs become more and more wooded, the stone only showing alternately in patches on opposite sides, and no lower view of the Jordan sandstone can be had, at least none that can be proved to be lower. Before reaching the Minnesota, however, a continuous bog is encountered, running along both sides of the creek, about ten or fifteen feet above the creek. This either indicates a change in the formation, bringing in a shale or clay, (perhaps a limestone,) or that the muddy alluvium of the Minnesota bottoms has been carried back up the Minneopa so as to shed the water of the bluffs. This bog is about on a level of the Minnesota flood plain, and the channel of the creek is cut in alluvium that cannot be distinguished from that of the Minnesota bottoms.

Seven or eight miles above Mankato, or one and a half above the wind mill, along the road to New Ulm, is another exposure of the Jordan Sandstone, with features very much like those at Minneopa. A little creek, which is dry in

summer time, exposes first about two feet of coarse sa stone in its bed. Following the creek down a few r there is a perpendicular fall of about fourteen feet, whic time of high water must make a handsome cascade, sim to the Minneopa waterfall. The immediate cause of the is the occurrence of a layer of about a foot with a harde more enduring cement, underlain by crumbling sandsto Over the sandstone rises the drift, about fifty or seve five feet, mainly made up of hardpan, (glacier drift) the t of which, however, is composed of fine sand in oblique st ification. The alternation of layers here is as follows:

No. 1.	Closely cemented sandstone, projecting beyond the next,	5 inc
No. 2.	Coarse, white sand, in waterworn grains, crumbling out easily	6 inc
No. 3.	Same as No. 1	6 inc
No. 4.	Same as No. 2	1 foo
No. 5.	Brink of falls. Same as No. 1	1 foot
No. 6.	Same as No. 2, seen	30 fee

This horizon is undoubtedly the same as that at Minne Falls. The appearance of the gorge below the falls, and t occurrence of a cemented part giving rise to the perpendi ular fall of the water, are very much the same. The be lie here, as there, nearly horizontal. The grains of sa are, perhaps, somewhat coarser here than at Minneopa.

This sandstone can be seen in the bluffs on the opposi side of the Minnesota river, surmounted by a great thic ness of drift. The bluffs are mainly wooded, but son smooth buttresses and slopes, wrought apparently in t drift, and covered with grass, yet reveal the stone, lar slabs and blocks from which lie on the hillside.

(f) THE ST. LAWRENCE LIMESTONE.

At St. Lawrence, which is about four miles northeast Belle Plaine, in Scott county, a still lower member of t Lower Magnesian is exposed, presenting somewhat differe lithological characters. It is harder than the Shako limestone, evenly bedded, quartzose and specked w green. These green specks have somewhat the appearan of coming from metamorphism, yet they are caused by lit rounded masses, which, if harder, would seem to have be water-worn and deposited with the sedimentation. Th are, however, rather soft, cutting like talc. They exact fill the cavities in which they lie. In some small portio they almost make up the bulk of the rock, which then has

green compact appearance, as if hornblendic. While the rock is evidently calcareous and magnesian in some parts, and almost destitute of these green specks, it is also siliceous and sharply crystalline. On analysis the little green specks have been found by Prof. Peckham to consist of lime, iron, magnesia and a trace of manganase. See p. 96, "Nos. 30 and 31."

The section here exposed is as follows:

Section at St. Lawrence, Scott County.

No. 1.	Beds two to four inches, with shaly partings and green specks	3 ft.
No. 2.	Beds fourteen to eighteen inches, hard, siliceous, occasionally porous from crystallization, specked with green, showing crystals of brown spar—a good building stone	4 ft.
No. 3.	Somewhat ferruginous, hard and crystalline, less porous than No. 2	2 ft.
No. 4.	Beds irregular, specked with green, and showing green surfaces	4 ft.
No. 5.	Band of greenish shale, sandy	6 in.
No. 6.	Beds two to four inches: magnesian limestone; seen about	1 ft.
	Total	14½ ft.

Quarries here are owned by Mr. Hewitt and Mr. Beason.

At Judson, on the right bank of the Minnesota, in Blue Earth county, is the only other known exposure of the St. Lawrence limestone in the valley of the Minnesota. It here occurs on both sides of the river, and is used for building stone. It was in traveling along the highway from Mankato to this place that the most indubitable evidence of the position of this limestone was obtained. Mention has already been made of the occurrence of the Jordan sandstone at Minneopa falls, and at a little waterfall by the side of the road, some miles above, (see p. 150). In passing northwestwardly the observer crosses nearly at right angles the direction of strike of the successive formations in that part of the state. Soon after leaving the little unnamed waterfall, above mentioned, and within three quarters of a mile, an outcrop occurs of a reddish, arenaceous limestone, very unlike the St. Lawrence stone, but similar to the outcrop in Jessenland township, in Sibley county, which will be further noticed as a possibly separate member of the Lower Silurian (see p. 155.)

Within that distance, or a little before reaching that waterfall, the road begins to pass down from a high, and rather

rolling, drift plateau, on to a lower plateau or terrace, overstrewn with boulders, like the terraces at Ottawa, Kasota and Shakopee, which skirts the valley for several miles, and indicates, as there, the advent of a hard, and resisting rocky foundation, into which the boulders cannot disappear. The surface of this lower plateau is mainly alluvial, the boulders lying in it, but not covered from sight. This red limstone occurs in the surface of that lower plateau. . At a half mile further the character of the rock which lies so near the surface is disclosed in a little opening by the roadside, apparently made for getting stone for use, but abandoned on account of the loose and shaly character of the beds struck. These shaly and thin beds, united perhaps with the red beds seen before, may have given rise to the boggy bench, already mentioned as occurring near the base of the Jordan Sandstone in the banks of the Minneopa gorge, since there so situated as to be very near the line of separation of that sandstone from the St. Lawrence Limestone. Near this little opening are two culverts that are constructed of stone, quarried of course near, like the St. Lawrance stone. Passing along this lower plateau about a mile, to Judson, the general surface features remain about the same. At Judson quarries, in the St. Lawrence, stone are owned by John Goodwin, and by Mrs. Wolf. On the opposite side of the river, at Hebron, the same stone is wrought by Wm. Phillips, Wm. H. Thurston and J. H. Dunham.

This is, lithologically, exactly the St. Lawrence stone, and has a dip of two or three degrees to the southeast. Supposing that to express the average dip from Judson to the last exposure of the Jordan Sandstone, there would be room for a thickness of thirty or forty feet of beds the character of which is not known. In that interval must fall the reddish outcrop three quarters of a mile northeast of the little unnamed waterfall, and probably the Jessenland outcrop, in Sibley county. Mr. Goodwin's quarry, near the ferry, shows eight feet of bedding, but lies twenty-five feet above the river. The beds are four to eight inches, although the uppermost three or four feet of the quarry are very much weathered and in thinner beds. The bedding planes are usually entirely covered with a green coating, and the body of the whole is specked thickly, and sometimes largely made up of green particles.

The other quarry of Mr. Goodwin, and that of Mrs. Wolf, both situated a little further up the river, are similar in characters and position to that already described. It is mainly

a limestone, and very durable, of a flesh-color, varying to buff, striped, specked and blotched with green. The sides of the bedding are almost altogether green.

Allusion has already been made to a reddish stone closely associated with St. Lawrence limstone, the geological horizon of which it is difficult to state. The first exposure observed of this occurs three miles above Blakeley, and on the west side of the river, in Jessenland township. It is in the river bottoms, N. E. ¼, sec. 12, T. 113, R. 26, owned by Mr. D. Doheny, who has opened a little quarry. It is a red, metamorphic limestone, nodular, concretionery, and filled with checks and planes of separation, the thickest beds being not more than four inches, the most of them less than two, and more or less contorted. It has greenish surfaces, and isolated pockets of fine, apparently copper stained materials, but very sparsely disseminated. It is almost a worthless stone for any use except macadamizing, owing to the ease with which the beds are fractured transversely. It is rough and irregular. It is fine-grained generally, rarely porous, and cryptocrystalline. When weathered it shows an arenaceous composition. It is seen in surface exposure over several square rods, the thin red chips covering the ground. About six feet of bedding may be seen. The position of this limestone is supposed to be somewhat above that seen at St. Lawrence, and below the Jordan Sandstone. It perhaps has not characters sufficiently defined and constant to be separable from the St. Lawrence. Indeed there are some good reasons for supposing it may be the uppermost portion of that limestone considerably charged with iron, and changed in outward appearance by the waters of the valley.

(g) THE ST. CROIX SANDSTONE.

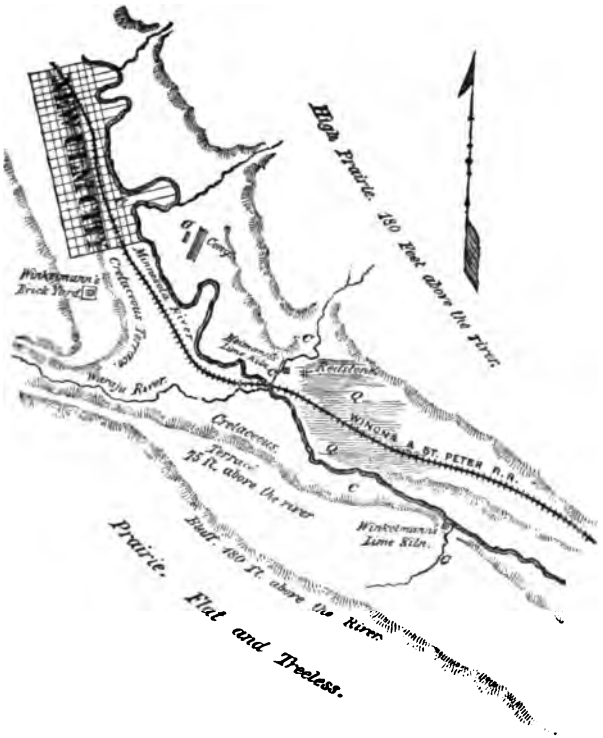
In the report of progress for 1872, this name was provisionally applied to the light-colored sandstones exposed largely on the upper Mississippi and on the St. Croix rivers, lying immediately below the Lower Magnesian. During the season of 1873, no observations on this series of sandstones have been made, and no new light can be added to the question of the age, of those beds, except what may be found in connection with the description of the outcrop of red quartzite at the mouth of the Waraju river, near New Ulm.

(h) THE POTSDAM SANDSTONE.

This name is here applied to the red sandstones that lie below the light-colored sandstones of the upper Mississippi valley, and to their supposed equivalents in the southwestern part of the state. The principal observations on this sandstone made during the season of 1873, were upon the outcrop near New Ulm. The annexed map of this locality will give a correct idea of the position of this outcrop in respect to the outcrops of conglomerate and granite which occur a short distance further up the river. A careful observation on the dip of the quartzite, south of the railroad cut, corrected for variation of the needle, gave 27° N. 10° E. A similar observation on the conglomerate gave a dip of 18° toward the E.S.E. The granite outcrop is located on the authority of Dr. B. F. Shumard, who says: "The granite is a hundred yards removed from the conglomerate, with its line of elevation running nearly parallel with the latter. Flesh-colored feldspar makes nearly two-thirds of the granite." This outcrop of granite was not noticed by the survey in examining this locality.

Map of the vicinity of New Ulm and Redstone, showing the position and dip of the Conglomerate and Quartzite.

Scale 1 inch=half a mile.



Explanation.

c. Cretaceous outcrop; beds horizontal.
g. Granite outcrop.
cong. Conglomerate outcrop; dip 18° E.S.E.
q. Red quartzite outcrop, dip 27° N. 10° E.

The dip of the quartzite varies in degree. It is greatest near the river, and is least near the northern extremity of the exposure. Indeed, near the northern extremity the surface has a slope which is apparently due to dip, in the opposite direction. A section north and south through the quartzite would show dip changing somewhat as illustrated by the following diagram, sketched on the spot:

Dip of the Quartzite at Redstone.



At the northern extremity of the exposure the surface of the rock shows a coarser grain, becoming almost conglomeritic. No true conglomerate can be here seen, but there are grains of white quartz as large as a mustard seed disseminated through it. The relation of this coarser portion to the rest of the quartzite is such as to cause it to *overlie* the most of the quartzite, but its actual superposition cannot been seen. In some of the thin bedding near the lowest part exposed, mica scales are visible on the planes of the bedding. When fresh they are black, but if weathered they are of a golden yellow color.

In many places there are evidences ot a higher stage of the Minnesota at some earlier time. These consist of furrows and water-worn surfaces. There are some pot-holes, worn usually so as to have their elongated dimension in the direction of the river, their shape being generally oval. One of the largest noticed was 20 inches long and 15 inches wide. Its depth was 24 inches. These water-marks rise 120 or 125 feet above the river.

On the north side of the river, nearly opposite New Ulm, is an outcrop of coarse jaspery conglomerate, the pebbles in which are occasionally a foot in diameter, and waterworn. There are also white quartzite pebbles. Ten feet may be seen, in an irregularly descending strike nearly north and south. The strike of this conglomerate outcrop is conspicuous in the woodless prairie, or terraced slope from the prairie. It rises from the very river bottoms and enters the bluff diagonally, at a hight of perhaps 50 feet above the river. The talus hides the underlying stone. The strike faces up the river.

The quartzite outcrop at New Ulm was described in general the report of the progress for 1872, (p. 75). The degree of dip and the thickness of the bedding exposed were, however, over-estimated. There may be 250 feet of stratification exposed, and the hight of the rock does not exceed 125 feet above the river.

The following is Dr. E. Emmons' description of the "Sandstone of Potsdam," taken from his report on the Sec-

ond Geological District of the State of New York, printed by the Legislature, in January, 1838.

"I shall not enter upon its geological relations, any further than to state, that in Potsdam, and other towns in which it appears, it uniformly rests on the primary strata; and in no part of the country is there any rock which interposes itself between it and the primary, so that it appears here as the oldest representative of the transition series. The identification of this rock with the sandstones along the southern border of Lake Ontario, will be a matter of some difficulty. It is geologically below the transition limestone, and never in the northern district alternates with it, but always holds the relation of an inferior rock. So much is known of its position, but still some doubt remains as to its general relation, and to its name and place in the series of rocks. Some call it the old red sandstone; others regard it as equivalent to the new, or saliferous rock of Eaton.

* * * * * * *

"This rock is a true sandstone, of a red, yellowish-red, gray and grayish-white colors. It is made up of grains of sand, and held together without a cement. Intermixed with the siliceous grains are finer particles of yellowish feldspar, which do not essentially change the character of the sandstone, but they show the probable source from which the materials forming it were originally derived, viz., some of the varieties of granite. Unlike, however, most of the sandstones, it is destitute of scales of mica. The coloring matter of the rock is evidently oxide of iron, but unequally diffused through it, giving it intensity or deepness of color in proportion to its quantity. In some places it is almost wanting, which makes it, when pulverized, a good material for glass. The grains and particles in its composition are generally angular, but where it takes the character of a conglomerate, as it does in the inferior layers, they are frequently rounded. The thicker strata exhibit an obscurely striped appearance, owing to the prevalence of certain colors in the different layers."

Quartzite similar to that described at Redstone was again seen in the southern part of Sec. 7, T. 106, R. 36, on land belonging to the St. Paul & Sioux City R. R. It presents here a small surface exposure, in a ravine, without exhibiting any distinct bedding. Its surface is glaciated in a direction, corrected for variation, S. 34° E.

At another point, perhaps in the edge of the next section west, (12) is a larger exposure of this quartzite. The

dip is 4° or 5° N. 10° W. The stone is very hard, but banded with light and red beds, evident on the planed surface and on the fractured side. This point shows glaciation S. 30° E. (corrected for variation.) There are other smaller exposures, further west a short distance. They occur frequently on the hillsides, where the drainage has washed off the light drift which contains a few boulders.

At still another point, in the same section, the glaciation is very evident. There is here a trench, traceable across the whole extent of the exposure, a distance of several rods, which does not perceptibly vary in direction. It is a foot across, and two inches deep, and its direction, corrected for variation, is S. 32° E.

There is an extensive and important ridge of this quartzite not yet visited, about in the northern part of T. 108, Ranges 35, 34 and 33, situated between the Big and Little Waraju rivers.

Mr. I. J. Rochussen is authority for the location and further items of other outcrops of this red quartzite. It may be seen, according to his description, on the edge of the valley of Rock river, in Rock county, three miles north of Luverne. It consists of a ridge three miles long, running N.E. and S.W., so far as known, its average height being 25 or 30 feet. The beds lie nearly horizontal or show a very slight dip, and are from one to four feet in thickness, and rather easily quarried. Also on the road to Sioux Falls, 15 miles west of Luverne, and two and three miles west and northwest of a settlement known as Valley Springs, are a number of outcrops, one large, isolated piece being known as *Lone Rock*. It is quarried at one point, and there shows conglomerate. At Sioux Falls, 15 miles further west, in Dakota, the same rock forms the fall, and lies in heavy layers nearly horizontal. The aggregate fall is 120 feet.

(i) THE GRANITES OF THE VALLEY.

The following account of the granites of the Minnesota valley will consist of a location of outcrops, and a description of their physical, outward characters. No attempt will be made to classify them, or to refer them to any horizon of rocks exposed in the northern part of the state. There has not yet been sufficient time to engage in mineralogical or chemical comparisons with the northern granites. There is no hesitation in saying that they are a southwestward exten-

side of those northern granites, and that their parallelisms probably exist and can be referred to their proper places, when a sufficiently detailed examination of the state shall have been made.

With the exception of the small exposure of flesh-colored granite near New Ulm, mentioned by Dr. B. F. Shumard, the first outcrop of rock of this kind occurs in ascending the valley at "La Framboise Place," where it rises seventy-five or a hundred feet above the level of the river. This is at Little Rock creek, about four miles below Fort Ridgely. The exposure has long been known among the French traders as La Petite Roche. It is one of a series of exposures in the same vicinity, extending along the river bottoms, mainly on the north side, for a mile or two. In general this rock is granite. It rises in low knolls, perhaps 50 feet above the flood-plain, visible from the "state road" that skirts along the foot of the bald drift bluffs on the north side of the river. Its outward appearance is that of a reddish granite, made up of the ternary granite compound, the separate grains of which are not coarse, the largest ones being the feldspar. The quartz is milky, or often amethystine; the mica is rather scarce for typical granite, and the feldspar is red or flesh-colored. The red color greatly predominates, giving a reddish tinge to the whole stone, wherever the weathered surface is kept free from lichens, or where the interior is freshly exposed by cuts for quarrying. The drift bluffs are not at all affected in contour or direction by these granite knolls, although the river itself winds about in the lowest channel accessible. No regular dip is distinguishable. The granite shows an abundance of seams and divisional planes, in various directions, that make it presumptuous to say which way the original bedding may have lain. The only circumstance that indicates the direction of dip is the occurrence of the most abrupt faces, in numerous places, on that side toward the river, the opposite slopes being more gradual, descending gently toward the north, as if the horizon of bedding sloped in that direction at an angle of 35° or 40°."

On close inspection of this granite with a pocket-glass, there seems to be much uncertainty about the color of the feldspar. The reddish color is most prevalent outside of the feldspar crystals, or only on their surfaces, as if the stain arose from rustiness and weathering, and had permeated the loosened granular mass by being in solution in water. There is a powdry, at least a gritty and sandy cement,

which fills the interstices within the mass and between the grains of quartz and the crystals of feldspar, that seems to be generally redder than the distinct quartz or feldspar portions. Yet that loose and more finely pulverized part seems to be made up entirely of quartz, appearing, on close examination, to have the light color and distinct fracture of glassy quartz, the red color vanishing from sight. The color seems to be located very largely in the cement, as in the red quartzite at New Ulm, suggesting the query whether this may not be more highly metamorphic sandstone. In a deep fracture, however, the red color is much less observable, being replaced by a gray, the feldspar grains becoming more evident, and the whole rock appearing much like the St. Cloud granite.

Above Fort Ridgely, by following the only passable road, a number of granite outcrops were not seen. At a point two miles below the Lower Agency, T. 112, R. 34, Sec. 10, Mr. Wm. H. Post lives on the bottoms, near the mouth of a little creek coming in from the north. From him the following statements of granite in the bottoms above Fort Ridgely were derived. It outcrops much more frequently on the south side than on the north side of the river. Throughout the whole distance to the fort (10 miles) occasional mounds of bare granite rise up in the bottom land. But these exposures are often quite small and at some distance from the river. At Marshner's Carding Factory, seven miles above the fort, are a number of granite knobs, in the vicinity of a lake situated in the bottoms. Half a mile further up is another exposure, but more or less connected, by smaller exposures, with that at Marshner's. The next principal outcrop between Fort Ridgely and Mr. Post's, is on the south side of the river, and is visible from his house. It shows a conspicuous bared spot, with some timber, rising in one place nearly as high as the enclosing bluffs, but not effecting the general level of the prairie, unless it be in causing, as has been observed in one or two other places, a knobby or rolling tendency in the prairie surface, with gravel and boulders strewn over the surface of the knolls. One very prominent rock rises nearly forty feet above the general level, cone-like, and can be ascended only on one side. It bears a few cedars.

At Mr. Post's, granite outcrops occur at two places in the bottoms. These rise but few feet above the general level. This granite has a strong resemblance to that at La Framboise's. It contains but little mica, and the feldspar is flesh-colored. The color here penetrates the feldspar crys

tals. In some places, however, the mica is more abundant, and the feldspar is less red.

Birch Coolie Creek joins the Minnesota in Sec. 5, T. 112, R. 34. The sides of this ravine, a short distance above its mouth, are in granite, which is more or less decomposed. It seems to have a dip S., SE., and SW. The only place where real granite can be seen is about 30 rods above the mill dam of Mr. Eldridge. It here rises 20 or 30 feet above the creek. In other places the creek runs over it, making rapids and falls, some of which Mr. Eldridge has improved for his mill power.

A substance was met with here for the first time which was afterwards seen at a number of places. Its origin seems to be dependent on the granite. Its association with the granite is so close that it seems to be a result of a change in the granite itself. It lies first under the drift, or under the Cretaceous rocks, where they overlie the granite, and passes by slow changes into the granite. It has some of the characters of steatite, and some of those of kaolin. In some places it seems to be a true kaolin. It is known by the people as "Castile soap." It cuts like soap, has a blue color when fresh, or kept wet, but a faded and yellowish ash color when weathered, and when long and perfectly weathered, is white and glistening. The boys cut it into the shapes of pipes and various toys. It appears like the pipestone, though less heavy and less hard, and has a very different color. It is said to harden by heating. This substance, which may, at least provisionally, be denominated a *kaolin*, seems to be the result of the action of water on the underlying granite. Since it prevails in the Cretaceous areas, and is always present, so far as known, whenever the Cretaceous deposits have preserved it from disruption by the glacier period, it may be attributed to the action of the Cretaceous ocean. In some places it is gritty, and in others it may be completely pulverized in the fingers. A great abundance of this material exists in the banks of the Birch Coolie, within a short distance of its mouth.

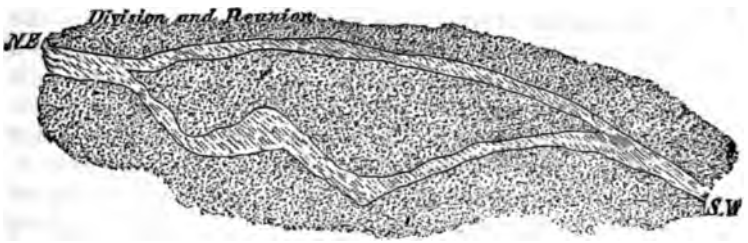
In the bed of the creek, above the mill-dam, several veins are seen crossing the smoothed surface of the rock. In low water these can be closely inspected, and their composition and structure ascertained. The following sketches illustrate some of their interesting features.

The Structure of Granitic Veins at Birch Coolie.

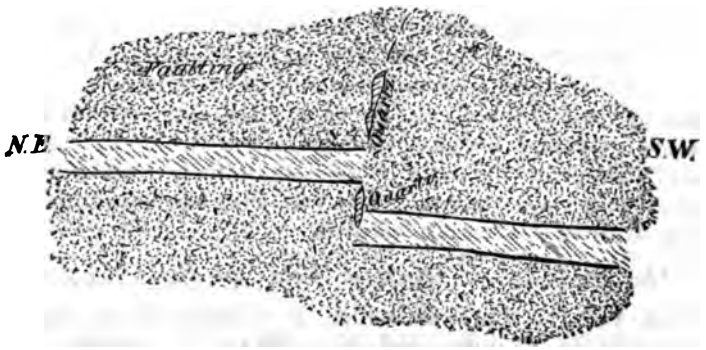
The vein, a part of which is illustrated by figures below, is in granite, and is made up of granite. The

constituent parts, however, in the vein, are much finer. than in the body of the enclosing rock, and show a deeper tinge of red color. Its direction is S.W., and it is four inches wide. It is visible along the creek 250 feet, and it is crossed by numerous other veins that are mainly quartzitic and narrow. The structure of the main vein is somewhat schistose, and seems to be harder, judging from its forming a ridge that stands above the general surface of the rock one or two inches. The laminae of the schistose vein run usually at some angle across the direction of the vein, but in one place, where there is a slight change in the direction of the vein, they nearly correspond with it. Their usual direction is nearer N. and S. This main vein is faulted in several places, and is divided so as to enclose an irregular oblong area at one point. The fault here sketched is accompanied by a very little quartzitic deposit, but there is no constant vein of quartz crossing the main vein, though there is a small indistinct seam that curves off to the south on the east side. The laminae in the two separated ends of the vein exhibit a curving in opposite directions, as if they had been somewhat elastic or plastic, and by being wrenched apart, had bent toward each other.

Division and Reunion of Vein at Birch Coolie.

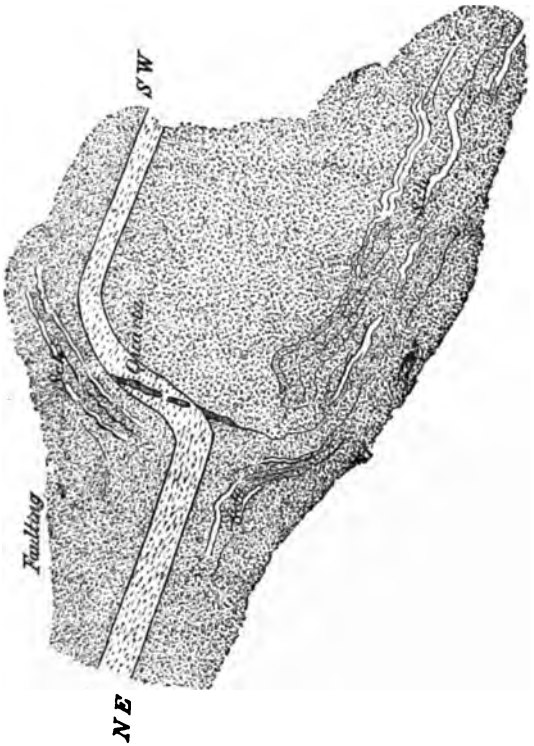


Faulting in Vein at Birch Coolie.



The following diagrams represent some of the effects of disturbance in changing the direction and structure of veins. The curvature represented in the first below, is a part of the same vein as described above. It is accompanied by a change in the arrangement of the minerals in the granite, producing a curving, schistose lamination.

Faulting in Vein.

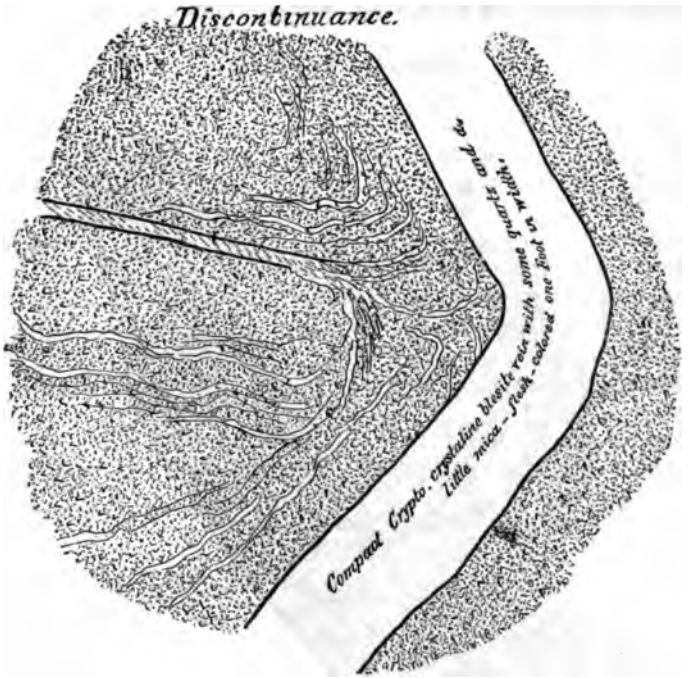


Sch=Schistose granite.

In the second, the same vein is intercepted by a vein that has the outward aspect of orthoclase felsite, which seems to be of earlier date, inasmuch as the former is discontinued on reaching the latter. The discontinuance of the smaller vein seems to have been the cause of a certain ramifying schistose structure in the vicinity of the point of contact of the two veins. The felsite vein is one foot wide, and has a

flesh color, with probably considerable quartz crystallized with it. It also shows some mica. It faults another vein, and hence is of later date than it.

Discontinuance of Vein in Granite at Birch Coolie.



[For "Compact, Crypto-crystaline blesite," read Compact, crypto-crystalline felsite.]

Granite of the same composition and outward appearance as that below Fort Ridgely outcrops on both sides of the Minnesota, at the mouth of Crow creek, Sec. 35, T. 113, R. 35. It is here also superficially decomposed to the depth of several feet, forming a substance resembling kaolin, already mentioned as occurring at Birch Coolie. The usual points of exposure of this kaolin are in the banks of the little ravines that enter the Minnesota river. It is generally overlain by deposits of Cretaceous age, comprising clay, lignitic shale, sandstone or limestone. When the water carries this kaolin out on to the bottoms, and there spreads it over the surface, it becomes dry after the subsidence of the water, and then appears as a nearly white, exceedingly unctuous, glittering scum covering the ground. In this con-

dition it shows minute flakes and sheets, that appear like exfoliations of talc.

At the mouth of the Redwood river, on both sides of the Minnesota, granite outcrops give rise to many rocky hills and knolls. The Redwood river, for some distance before reaching the Minnesota bottoms, is channeled through granite rock. This, together with the excavated Cretaceous rocks overlying, and the drift deposits, gives the river a very deep gorge through which it flows at a rapid rate, sometimes plunging over precipitous or perpendicular rocky descents, presenting a series of waterfalls, rapids, and quiet, deep pools of confined water, which are rarely excelled for picturesque beauty. The river falls about 100 feet in half a mile.

The granite, through which the river is canoned, is usually the typical ternary compound, but shows variations. It is sometimes slaty or schistose. Just below the flouring mill of Messrs. E. Birum and Brothers, the rock on the left side is cut by divisional planes into oblique cuboidal blocks, and is called, in the absence of better, a "building stone," from the ease with which it could be quarried. It is also schistose made up largely of quartz grains which are coarse, mingled with fine, glittering flakes that may be talc or mica. The greenish color of the whole stone, on fresh fracture, gives the rock a talcose character, although there are also occasional black scales that are plainly micaceous. The most frequent divisional planes here, causing the slaty or schistose structure, run about NE. and SW., and slope at an angle of about 25 degrees below the horizon, toward the SE. This rock might be denominated a schistose and talcose quartzite.

At Redwood Falls the granite is overlain by the kaolin, which has been mentioned, presenting, in connection with this substance, a very interesting series of exposures, and suggesting very interesting questions both economical and scientific. About a mile below the village, on the left bank of the river, is a conspicuous white bluff,* composed of white kaolin clay. Near the top of this bluff, where the rains wash it, it is silvery white, and that color is spread over much of the lower portions, though the mass of the lower part is more stained with iron, having also a dull greenish tinge. The white glossy coating which appears like the result of washings by rains, is spread over the perpendicular sides. On breaking off this glossy coating, which is sometimes half an inch thick, the mass appears indistinctly

*This is probably that seen by Keating, and pronounced "white sandstone."

bedded horizontally, but contains hard lumps and irony deposits. Further down, the iron becomes more frequent, and gritty particles like quartz impede the edge of a knife. The bedding also is lost, and the closest inspection reveals no bedding. Yet there is, even then, a sloping striation or arrangement of lines visible in some places on the fresh surface, that corresponds in direction with the direction of the principal cleavage plane of the talcose and quartzitic slate already described. In other places this arrangement is not seen, but the mass crumbles out in angular pieces which are superficially stained with iron. The profile of the bluff here presents a singular isolated knob or buttress that rises boldly from the very river, connected with the main bank by a narrow edge along which a man cannot walk with safety. On either side of this bold promontory are retreating angles in the bluff along which a descent can be made. A careful inspection of these ravines and of the adjoining bluffs affords indubitable proof that this material, white and impalpable as it is, results from a change in the underlying granitic rocks.

Just above this point, is another exposure. It here supplies what is locally known as the "paint rock," from an enterprise started several years ago in the manufacture of mineral paint from this material. The decomposed granite here has very much the same appearance as the kaolin, already described, at Birch Coolie, but contains more quartz, and is more stained with iron. It has a greenish color, but within might be blue. It passes upward into the greenish, and then white, kaolin clay already described, but it stands out in a crumbling, rusty buttress, exposed to the weather, and has quartzitic veins and concretions, iron-coated, and often an impure iron ore in considerable quantities. It shows silvery or shining talcose flakes, the same as seen in the so-called building rock, a short distance below the mill of Birum brothers.

A short distance above this, nearly opposite Redwood Falls, is situated the rock which was quarried for the manufacture of paint. This has in every respect the same character and composition as that last described. It consists of a perpendicular bluff or point, standing out from a lower talus that rises about 75 feet above the river, to the hight of 75 feet more. On the top of this is the drift-clay hardpan, covered by four or five feet of sand and gravel, the whole bluff being about 150 feet above the river. This bold bluff, or promontory, stands between re-entrant angles, its face tall-

ing down sheer thirty or forty feet. There is here visible an irregular slaty or cleavage structure in the rock, that at a distance has the appearance of dip toward the S.E. 30°. This also contains quartz veins and deposits, accompanied by iron, in some places too abundantly to allow of being cut with a knife, though very much of it can be easily shaped with a knife. It shows "slickensides," or surfaces that seem to have been rubbed violently against each other, causing a scratched and smoothed appearance, even within the body of the bluff. These surfaces are concave or curving, like putty hardened after being pressed through a crevice.

Between Beaver Falls and Vicksburg the granitic rocks appear almost constantly in sight, rising in mounds or bald irregular slopes, along the river bottoms, reaching occasionally as high as the river bluffs. For some distance above Beaver Falls, a ridge of granitic rock, running along within the bluffs, divides the channel into two parts, both of which are sometimes occupied by water, no such rock, nor any other, being visible in the bluffs themselves.

At eight miles above Beaver Falls such rock occurs in great force in the river bottoms, giving the appearance of a village, at a distance, partly hid by the scant foliage. Here it occupies the whole valley, spurs running in either direction into the river bluffs.

At Vicksburg the river bottoms are crowded with granite mounds and hills, some of them holding large blocks of hornblend schist that lie *in situ*, the transition from granite to schist being very abrupt.

After passing Patterson's Rapids (T. 114, 37), the next important granite exposure noted was at Minnesota Falls, situated in the north part of town 115, range 39, although small mounds of granite occur for three miles below. Here the river bottoms are occupied by a schistose granite, which splits up conveniently for foundation stone. The change in the character of the rock is evident in the generally turfed condition of the mounds. The rock is here intersected by veins of quartz and trap dykes, the latter being traceable across the valley for half a mile, running N.E. and S.W. This trap is heavy and dark green, with some shining faces on the hornblend, when freshly broken. In higher levels, and apparently overlying this bedded schistose granite, is a compact hard-weathering granite. It is of a gray or greenish-gray color, much resembling the St. Cloud granite. The rock at Minnesota Falls differs very notice-

ably from any observed in the river valley at lower points. It is bedded, and has a strong dip towards the S.E.

At a point, a short distance from the river, up a little ravine, that joins the Minnesota, opposite Austin and Worden's flouring mill at Minnesota Falls, the mineral already described as kaolin, or "paint rock," may be seen. This decomposing granite here holds quartz veins and deposits; which being coated with a lustrous black mineral, or holding it in sheltered angles or cavities, has attracted the attention of the settlers, who have regarded it as possibly an ore of silver or of copper. This mineral has a dark, brown powder. When in the form of films or sheets, or larger globules, it parts with a specular cleavage. In some places a considerable iron rust is seen in this quartz, and in others drusy or peppery crystals, as if of the same composition, are scattered over the surface, making it appear specked under the glass. These fine crystals make a lighter powder. Prof. Peckham pronounces this mineral to be haematite iron ore. It is specular.

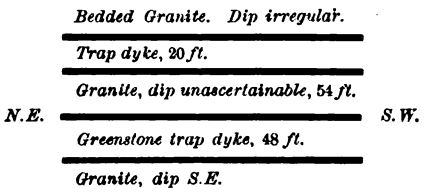
The valley all the way between Minnesota Falls and Granite Falls is about two miles wide, and presents a singular billowy prospect, of granitic knobs, rising and falling on all sides, the river worming its way among them and having frequent rapids and water-falls, useful for mill privileges. At Granite Falls, as at Minnesota Falls, and all the way between, the rock in the valley is a schistose granite, almost a mica schist; but it varies to a hard gray granite that resembles that at St. Cloud both in color and composition. This, however, forms but a small part, the greater portion being schistose or laminated. It also varies to a red granite, i. e. one in which there are evident flesh-colored crystals of feldspar. These two variations do not seem to lie with any ascertainable fixed relation of superposition to the schistose or bedded granite, but rise in knobs and irregular masses higher in the valley than that. They are not wooded, nor turfed, the schistose granite which more easily decomposes being generally turfed.

The most marked peculiarity of the granite at this place, is its constant dip toward the S.E. This has been observed at several other points before reaching Granite Falls, but some uncertainty has generally existed in regard to the true character of the lamination seen, and it has not been spoken of as dip. Although the usual direction of inclination is toward the S.E., it varies, at Granite Falls, from S.E. to N.E. It amounts to 25 degrees, but sometimes reaches 40

degrees. At one place at Granite Falls the rock dips to the north for some distance. The red and grey colors are variously mingled, without any apparent law of association or alternation. Although the patches of more massive and typical granite are suitable for a fine building material, they still show the same dip toward the S.E., and are distinctly bedded throughout. These hard knobs rise from ten to twenty feet above the general level of the other granite, and show various effects of running water.

The trap dykes, the direction of which is shown by the adjoined diagram, occur in the river bottoms, about a mile above Granite Falls.

Trap dykes at Granite Falls.



There are sudden changes in the rock from real granite to hornblendic schist. These occur irregularly. A change like this gives rise to the waterfall near the flouring mill of Hon. Henry Hill, the fall being due to the greater resistance of the harder rock. The trap dykes above mentioned also cause rapids and waterfalls where they cross the river.

Between Granite Falls and Montevideo, at the mouth of the Chippewa river, the granite occasionally appears in the river bottoms. It was noticed at a point six miles below Montevideo, on the north side. The bedding, supposed to be due to original sedimentation, still dips to the east. It appears sometimes to stand nearly vertical. At this place occurs a belt or bed of hornblendic schist.

At two miles below Montevideo, is a conspicuous outcrop of compact hard granite, of a red color, lying mainly on the north side of the river, in the bottoms. This has the same dip, viz., 30 or 35 degrees to the southeast. The beds here regarded as representing dip, and at other points mentioned, should be further described. They are in thickness ½ to 2 or three inches, or they seem sometimes to be a foot or two. When weathered they appear thiner, and the granite then sometimes presents a slaty structure, the edges standing out sharply at the angle of dip. At Minnesota Falls,

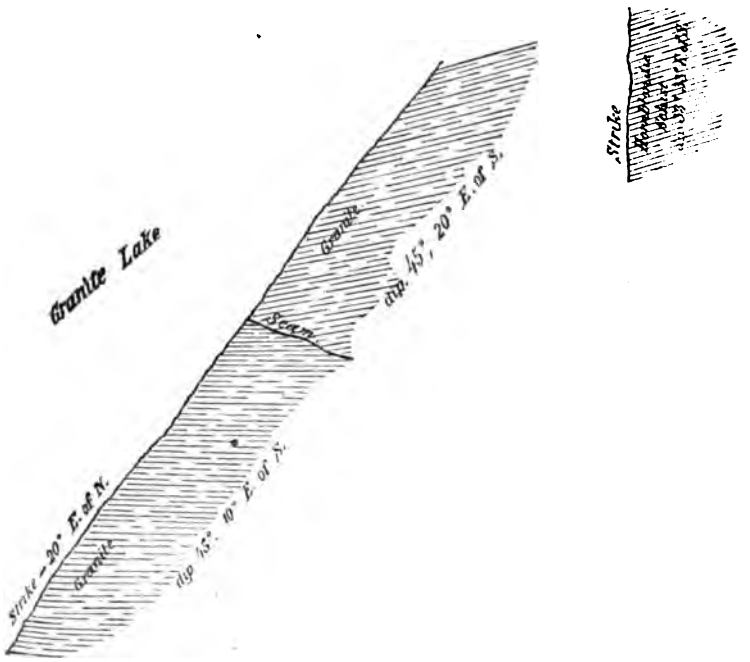
and from there to Granite Falls, these beds are so micaceous as to make what has been termed a schistose granite, the whole mass becoming easily disrupted by frost and water, and then turfed over. But at this place the beds are closely compacted, and the whole is almost massive. The thickness of the bedding can easily be seen, however, in the occasional thin sheets that part from the knobs, or in the striations that mark the faces of the waterworn, bald knobs. Although these knobs rise at irregular intervals, and are variously situated with reference to each other, having sloughs between them, yet they are arranged somewhat in succession in one direction, making rows or almost sometimes continuous ridges, running parallel in the direction of the strike, N.E. and S.W., which of themselves indicate a system of bedding. On a weathered cross-section of the bedding, the marks of striation or sedimentation often show a wavy arrangement, or distorted parallelism, and sometimes they vanish and widen alternately. The dip measured in one place is here 58°, 10° east of south. At another point, very near the last, it is 85° in the same direction. This granite has the color and apparent composition of that seen below Fort Ridgely.

This granite shows occasionally a knob of hornblendic schist, rising among the granite mounds, having very much the form, dip and bedding of the granite.

There is also occasionally a mound or dyke of trap, or greenstone, split into shapeless blocks under the weather, the planes of division running in various directions. These have no bedding, nor dip, but are very heavy, and uniformly of a dark green color. They do not disturb the uniformity of dip in the granite.

The following diagram will exhibit some of the features of the granite as exposed two miles below Montevideo:

Granite two miles below Montevideo, Chippewa Co.



The change in the direction of dip in the granite here sketched is rather less sudden than here represented. The seam, or joint, marking the point of contact of the beds dipping in different directions, is very much covered with turf, and the manner of union cannot be ascertained definitely, but on the face of the bluff (strike) there is no apparent disturbance or irregularity.

A belt or wedge-shaped, lenticular mass of hornblendic schist occurs in the granite here described, on the land of Mrs. E. A. Hull, having more easterly dip, and running N.W. and S.E. It is 20 rods long, and from 20 ft. to 6 rods wide. Its dimensions and form cannot be fully and exactly seen. It appears in low knobs much like the granite, and the intervals of non-exposure are grassy.

Mr. L. R. Moyer, county surveyor of Chippewa county, reports granite on the prairie, three miles east of Montevideo, and in the Minnesota bottoms, a mile above Montevideo.

Near the lower end of Lac-qui-parle lake, granite appears on both sides of the lake. It is usually inaccessible from

the prevalence of water; but in the dry months of the year it can be reached on the north side without any trouble, except from tall grass and bushes. There are three or four small bare spots on the south shore that can be seen, and three or four others that rise up in the midst of the lake. Two of these spots of bare rock also occur on the north side, near the foot of the lake. This rock, so far as can be seen on the north side, shows very much the same composition as further down the river. It contains quartz, mica and flesh-colored feldspar, with patches and veins of quartz, some of which are mingled with porphyritic feldspar. The exposed surfaces are annually submerged, or nearly so, and do not exhibit very plainly such markings as indicate sedimentation or dip. There seems to be an indistinct arrangement of the mica scales, so as to give the rock a schistose structure, but this, although generally running N.E. and S.W., does not have that direction invariably, and does not at all represent the lamination or bedding seen below and already described. In only one small area can there be seen what looks like the same bedding, and there it is but six inches in thickness, the beds being one or two or three inches, with a dip of 75° toward the S.E. Jointing planes divide the whole mass into blocks and rhombs, four or five or six feet in thickness. There is a considerable low land about the lake, much of which is flooded at the wet season of the year, but it is stony and bushy, and has the appearance of rock in a great many places near the surface. Such appearances are seen the whole length of the lake, and especially on the north side. About three miles above the foot of the lake, rock can be seen on the south side at two points, rising plainly above the general level of the bottoms, and ascending in the slope from the prairie. Such exposures continue to near the head of the little lake on T. 120, R. 44, where granite appears in several places on the south side of the river.

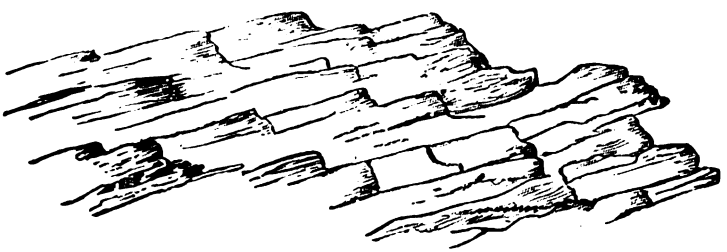
Further up the river, near where it enters T. 120, R. 44, may be seen a large exposure of coarse granite. The crystals of feldspar are large and flesh-colored, or red. Yet the granite also varies to a lighter color, in which the feldspar is nearly white. It shows, in the latter case, a perpendicular jointing, the planes being one or two or three inches apart. The whole exposure consists of bare, massive, rounded knobs, cut into angular rhomboidal blocks, by jointing planes, but in no place showing the dip seen lower down the Minnesota river.

Granite also outcrops about three quarters of a mile above Mr. F. Frankhouse's, on the south side of the river, two miles above the last.

Red granite also appears about a mile further up, in the river bottoms, near Mr. W. Movius' house, presenting an irregular exterior, showing no dip, although there are here also conspicuous jointing planes. This is about three-fourths of a mile above the mouth of the Yellow Banks creek. Opposite Mr. Movius', on the south side, in the bottoms, may be seen another similar granite mound.

At three miles below the foot of Big Stone Lake, there is a tumultuous outcrop of red granite, extending to the lake on both sides of the river. This shows planed and striated surfaces on a grand scale. These marks have a N.W. and S.E. direction (corrected for variation), or that, in general, of the Minnesota valley. The whole rock, including the upper surfaces and the sides of the mounds, is planed off. The best exhibition of these markings is seen on the northwestern slopes, in which direction there is a system of jointing planes, dividing the granite into blocks that have at first sight a strong semblance of dip, the masses breaking off more nearly at right angles on the southeast side. This is a coarse, red granite, with large crystals of feldspar. The following diagram illustrates the effect of the jointing in the rock, acted upon by glacial forces from the northwest.

Jointing and Glaciation at Big Stone Lake.



Above the foot of Big Stone lake there is no known outcrop of granite throughout its extent. Cretaceous rocks constitute the only outcrops. These are seen sometimes in the little creeks that enter it, and are outlined as terraces on its banks.

The examiners of the land of the Winona and St. Peter R. R. report granite *in situ*, on the prairie T. 113, R. 43, Sec. 17, and T. 113, R. 39, Sec. 29.

Further examination of the granitic belt was made at Sauk Rapids and St. Cloud, for the purposes of comparison with the granites of the Minnesota valley, and with a view to some parallelization; but as that region will undergo a more detailed survey, and no results were obtained bearing on the subject of the relative age of the rocks at that place and the granite of the Minnesota valley, those observations are reserved for future comparisons.

(j) THE CRETACEOUS.

In the progress of the season's work, the first point at which these rocks were seen was in Dakota county. At Empire City, where the highway crosses the Vermilion, Sec. 24, T. 114, R. 19, the river is handsomely terraced. The valley between the lowest benches that rise on each side is from one to two miles wide. The first terrace is very conspicuous in the treeless landscape, and consists superficially of coarse drift. Its crest is gently rounded off. It is occupied with fine farms. The same is true of the land lying along its base, which might be called the flood plain of the river. Yet it is probable the river never floods the greater part of it. Some of this plain is wet and grassy, making fine meadow land, and other parts of it are plowed for wheat. The first terrace seems sometimes broken, about midway, into two terraces, the constancy of which could not, however, be discovered. It is subject to numerous re-entrant bends and other sinuosities, the points intervening being stony and only fit for pasturage. The pebbles are generally quartzitic, and lie very thick on the surface. They are rounded as by water. The hight of this terrace above the river, measured by Mr. Furber by Locke's level, was found to be 81 ft. 3 in. Above this terrace there is a further ascent to the level of the general prairie. What part the St. Peter sandstone, which forms Lone Rock a short distance north, and shows an outcrop in the valley a short distance up the river, plays in the formation of this terraced slope to the Vermilion, cannot be certainly ascertained, but it probably is very small. The Cretaceous clays and shales, with their associated loose sandstones, however, are perfectly adapted to the formation of terraces along streams, as has been, and will be further mentioned in describing the Minnesota valley, and they are believed to be the sole cause of these terraces. If the reader wishes to investigate this subject further, he is referred to those chapters and para-

graphs that describe the terraces of the Minnesota, and discuss the drift and its phenomena. This assignment of these terraces to the agency of the stratified deposits of the Cretaceous does not rest on bare opinion. The Cretaceous clay was seen in outcrop near the bridge over the Vermilion near Empire City. The destructible nature of these beds causes them to be covered by loose materials, which, after the lapse of time, spread over the entire surface, and superficially appear to compose the whole substructure. The beds themselves are thus only outlined in the form of terraces.

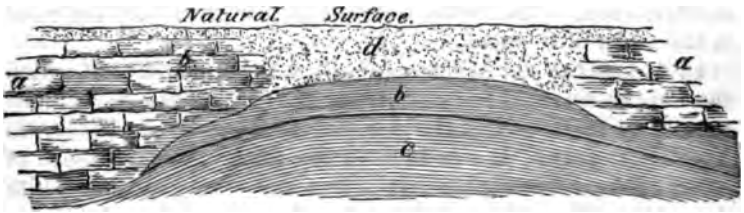
In ascending the Minnesota valley the first point at which the Cretaceous was identified, so far as it can be without the aid of fossils, is at the Asylum farm, near St. Peter, in Nicollet county. It lies here in the water-worn openings of the Shakopee limestone. It is a white, or greenish-white deposit, holding much sand. It has a great many flinty fragments, and some siliceous limestone lumps. The latter are rounded, but the former are angular. The lumps are porous, crystalline, hard, and gray or white. No fossils can be seen, and no stratification. It seems rather to have been *jammed* into the openings in the Shakopee stone. A similar exposure, presenting the same characters, occurs across the river from St. Peter, and about a mile toward Kasota, in a bluff by the side of the road.

A heavy bed of white sand, which has been described as probably belonging to the St. Peter sandstone, (p. 134), occurs on the Blue Earth and its tributaries. It is associated with an impure iron ore, and with light green shale, but its exact relation to them has not been ascertained. It may belong to the Cretaceous.

At Mankato, in Blue Earth county, a series of very interesting observations were made on the Cretaceous, throwing some light on the history of that period of submergence which brought the most of Minnesota below the ocean. Where the road to South Bend crosses the Blue Earth, on the east side of the bridge, is a cut in greenish clay, by the side of the road. This deposit of clay lies in a nook alongside the bluff of Lower Silurian, and doubtless was protected from destruction in the glacial period by that bluff. It is covered with drift, and at one place occupies a cleft in the Silurian rock, running nearly to the surface of the ground at the top of the bluff. Its position here, and as represented in the following sketch, is very deceptive. It appears very much as if in place in the Shakopee stone, but

the beds of that stone hold as low a place, horizontally, a little further to the left, as this clay. The bluff of Lower Silurian can be seen to disappear behind the clay, in some places the clay being removed so as to show the bluff at lower points than at others. There is every indication that this deposit is of small extent.

The Cretaceous at Mankato.



Explanation.

a. Shakopee Limestone.
b. Bedded, greenish clay, weathering white, but little sandy.
c. Sandy, bedded greenish clay.
d. Drift, mostly coarse fragments of Shakopee Limestone.

Passing along the right bank of the Blue Earth river from the highway to the railroad bridge, we come to a cut in the Shakopee stone. This is in the same horizon as that just described, and shows more fully the manner of superposition of the Cretaceous on the Silurian rocks. This cut is perhaps 70 feet above the river, the bank of which is composed entirely of rock, the lower portion of which is the Jordan Sandstone, and the upper, the Shakopee limestone, the latter comprising about 20 feet. In general this railroad cut shows a mixture of Cretaceous clay with the Lower Silurian, the top of the whole being thinly and irregularly covered over and chinked up with coarse drift. The Lower Silurian is more or less broken and tilted, at least the bedding seems to have been cut out into huge blocks by divisional planes, which, either by weathering or water-wearing, were widened, the blocks themselves being subsequently thrown to some extent from their horizontality, tipping in all directions. The opened cracks and seams were then filled with the Cretaceous clay, which is deposited between these loosened masses, and sometimes even to the depth of twenty feet below the general surface of the top of the rock. The clay sometimes occupies nooks and rounded angles, sometimes sheltered *below* heavy masses of the Silurian beds.

The clay is uniformly bedded, about horizontally, with some slope in accordance with the surface on which the sedimentation took place. But the most interesting and important feature is *the condition of these old Silurian surfaces*. They are rounded by the action of water, evidently waves. The cavities and porous spots are more deeply eroded, making little pits on the face of the rock; or along the lines of section of the sedimentation planes with the eroded surface, there are furrows due to the greater effect of water. The rounded surface of these huge masses of Lower Silurian is coated with a thickness of about a half inch, or an inch and a half, of iron ore, which scales off easily, and is easily broken by the hammer. While this scale of iron ore is thicker near the top and on the upper surface of the blocks, yet it runs down between the Cretaceous clay and the body of the rock, so as to prove its date older than the clay. The conclusions that must be drawn from this observation are about as follows:

1st. The Silurian rocks were long weathered, and washed clean, even waterwoan and rounded, at this place, when they went below the Cretaceous ocean. Nothing intervenes their iron-stained surfaces and the clay.

2nd. This point seems to have been on or near the ancient shore line, where the violence of the waves was great. These rounded knobs could not have received their coating of iron if constantly submerged. The iron indicates the action of atmospheric gases on iron held in solution in water, as in bog ore formation.

3rd. The Cretaceous clay here, whatever be its place, in the Cretaceous age, was deposited in a quiet ocean.

4th. This bluff, facing to the south, or south-east, like that at Mankato, indicates the approach of the Cretaceous ocean from that direction, though this may have been only a reef, or an island, just before the further submergence.

5th. There may have been, and was probably, a further deposition of clay of the Cretaceous age which was destroyed and transported by the Drift Period, at this place.

6th. The drift succeeded, and was not violent enough in its forces to disturb these tilted and waterworn masses of Lower Silurian limestone, so but that their old surfaces abut still unconformably against the Cretaceous clay.

7th. The Cretaceous sea must have advanced slowly over the Silurian rocks. These washed surfaces could not have been produced when the sea was retiring, else the Cretaceous sea would have washed out the clay. Further the clay lies directly in contact with these surfaces.

8th. The Cretaceous sea must have gone further north and east so as to deeply submerge these disturbed masses, in order to have deposited such fine sediment in their crevices.

9th. While the washed surfaces indicate a shore line, or a reef, the clay proves deep submergence.

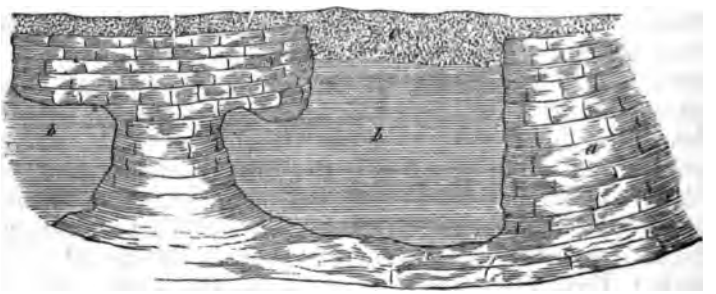
10th. The Cretaceous sea must have retired rapidly, so as to give no opportunity to wash out the clay.

11th. These washed surfaces must have been produced as the sea was advancing.

12th. While it is certain that the Cretaceous sea advanced slowly on the land, it is not certain that it retired rapidly. The clay existing there may have been protected from the retiring shore waves by superimposed beds hundreds of feet thick—such higher beds having been subsequently removed by the drift forces; but it is likely that drift forces that were able to destroy so much Cretaceous, would also so have disturbed the Silurian masses as to leave no trace of the clay, or even to have transported away the Silurian masses themselves. Hence it is probable that there was but little Cretaceous deposited over the remaining clay, and that the sea retired rapidly.

The adjoined sketches will give a better idea of the position of the Cretaceous, with respect to the Silurian.

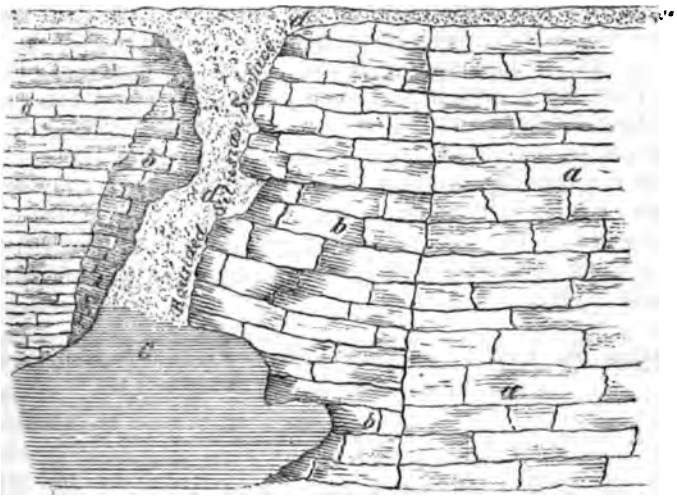
The Cretaceous on the Lower Silurian.



Explanation.

a. Weathered surface of Silurian.
b. Cretaceous Clay.
c. Coarse Drift.

The Cretaceous on the Silurian.



Explanation.

a. Silurian Rock, cut by the grading of R.R.
b. Weathered surface of Silurian Rock.
c. Cretaceous clay, greenish blue, bedded.
d. Coarse Drift.

On Sec. 25, T. 108, R. 29, (as nearly as can be made out) is an exposure of Cretaceous Clay. The bank of the flood plain of the river is made up, almost everywhere, of sandy, more or less stratified, alluvium. But here, although having about the same hight, it is made up almost entirely of a mass of large, water-washed fragments of conglomeritic sandstone, which lie in confusion, some having fallen down into the water. They are underlain by a fine blue clay, without gravel or pebbles, belonging to the Cretaceous. Hence the sandstone or conglomerate pieces are not *in situ*, but pertain to the drift. Sometimes a layer of drift-pebbles and cobble-stones, about three inches thick, separates them from the clay. These large masses are 8 or 12 feet long, and 5 or 6 feet thick, and are scattered in talus over the Cretaceous clay, even into the river.

Dr. B. F. Shumard, in his report on the Minnesota valley, has mentioned an outcrop of *Formation* 1, *capped with about 25 feet of gray, concretionary limestone*, about two miles below the mouth of the Waraju, and describes it as having disseminated crystals of calcareous spar. His analysis shows it to hold 90 per cent. of carbonate of lime. A

very long search was made for this exposure in the season of 1873. It could not be found—that is to say, nothing could be found pertaining to the Silurian rocks. A sandstone was seen in outcrop on Sec. 16, T. 109, R. 29, on the north side of the river, in Nicollet county, quarried a little by Wm. Fritz, which proved to pertain to the Cretaceous, holding dicotyledonous leaves and branches. It consists of alternating layers of friable sand with angular shapes, but little rounded by attrition, and hard, cemented gray sandstone, which is sometimes coarse enough to be styled conglomeritic. The section here is as follows, the upper members being somewhat displaced by the washing out of the friable layers.

Section in Cretaceous Sandstone. Land of Wm. Fritz. Sec. 16, *T.* 109, *R.* 29, *Nicollet Co.*

No. 1.	Hard, gray sandstone, rusted in the weather, and checking into beds of about four inches,—sometimes one or two inches	18 in.
No. 2.	Friable white sand	10 in.
No. 3.	One course of gray sandstone, of variable thickness	1–3 ft.
No. 4.	White sand	6 in.
No. 5.	Gray sandstone, quarrying out in layers 6–10 inches thick, but in the quarry appearing massive; very hard, the cement appearing to be silica. It contains fragments of wood, charcoal and angiospermous leaves. Its under surface is undulatory, its thickness varying from	3–6 ft.
No. 6.	White, friable sand, seen	3 ft.

This whole quarry lies perhaps 35 or 40 feet above the river, and 40 or 50 rods from it. The persistency of this group of layers is evidenced along here by their forming a little terrace above the bottoms, which rises about 25 feet, and is visible for more than a mile. Pieces of this stone had been seen at lower points on the river, said to have been taken from the beds *in situ*, but it had been impossible to find those beds. One such place was at Mr. E. Rowe's, on Sec. 23, T. 109, R. 29, on the south side of the river.

Four miles below New Ulm, on the south side of the river, is a bluff made up of Cretaceous, on the land of John Gruebel, as follows:

Section on Sec. 2, *T.* 109, *R.* 30.

No. 1.	Black alluvium	2 ft.
	Passing below into—	
No. 2.	Clayey alluvium, of a light-brown color	4½ ft

No. 3.	Red clay, containing some sandstone in masses; stratified	2½ ft.
No. 4.	Belt of greenish, sandy clay	1 ft.
	Passing into—	
No. 5.	Sandy clay, of a light umber color	1½ ft.
No. 6.	Bedded sandy clay, of an earth color, (same as No. 2)	2 ft.
No. 7.	Greenish sand, the color coming from the mixture of green shale with the sand, the grains of sand being white quartz	2 in.
No. 8.	White sandstone, in one bed, or weathering into beds of two inches	1 ft.
No. 9.	Green bedded shale, or clay, with some fine sand grains, and some laminations or thick beds that are all white sand, but generally maintaining a green color, seen	18 ft.
No. 10.	Slope and talus	10 ft.

The bedding seen in the foregoing section is horizontal, and shows no fossils. Although there is no opportunity at this place to determine whether this series of shales lies above or below the sandstone at Fritz's, by an observation made in the bank of the road at the crossing of the Waraju, it is believed to overlie that sandstone, but to underlie a series of calcareous beds that appear in the right bank of the river, about a mile below the mouth of the Waraju. The colors near the top of the foregoing section exchange places a little, in following the bluff along, drift boulders and gravel occupying the place of clay, in No. 3. In some places the red, irony stain passes down lower. It is likely that the red, brown and ochery colors are due to ferriferous waters, since the deposit of the Cretaceous, and to oxygen in the air. Hence it is not certain that the drift extends through the whole of No. 3, although drift boulders are mixed with it, or replace it, in some places. When evenly bedded and free from boulders, it undoubtedly belongs to the Cretaceous, the drift stopping with No. 2. When it is replaced by boulders, the Cretaceous is only so much the more worn away, the color pervading them, or passing down to lower beds.

From the mouth of the Waraju going down the right bank of the Minnesota, a regular terrace is seen to rise several feet above the flood plain. About a mile down, this terrace shows its origin and composition, in the banks of a ravine which cuts it. (See map of this locality, page 157.) Before reaching that point, however, an outcrop of "gray concretionary limestone" is seen on the top of the terrace plateau. This limestone here is overlain by a couple of feet of water-washed limestone, gravel and cobble-stones, mixed toward the top with the usual black alluvium. The appearance of the quarried stone is like *drift* pieces, and the bed from which it is taken is intersected variously with

divisional planes, cutting the mass into irregular fragments which, on being taken out, appear weathered. Yet ther are crystal-lined cavities, some parts of it being mostl made up of calc-spar. Since the formation of the crystals calcareous water has again deposited lime on the edges o the crystals, which, having first been of the thin (axe shaped) variety, have now the appearance of separate bu crowded cock's combs, the little, beaded accretions of lim being arranged on their edges. There is also a consider able quantity of uncrystallized lime on other surfaces. Th interior of the stone is of a light gray or drab color and when compact and free from crystals, is very fin grained. It is said to make a white, strong quicklime, o which there can be no doubt. This limestone outcrop, whic shows only about 16 inches, is within a mile of the re quartzite outcrop near New Ulm, the bare, bald surfaces o which are visible, from this point, on the other side of th Minnesota.

A little below the last described exposure, is Mr. Wm Winkelmann's lime-kiln and quarry. The stone her burned is in the same horizon, and comes from the banks o a ravine that here enters the Minnesota. The limestone i much mixed, confusedly, with shale, but the following gen eral section can be made out, in which no fossils were seen

Section at Wm. Winkelmann's, near New Ulm, in Brow County.

No. 1.	Alluvium and boulders	2 f
No. 2.	Green shale, interstratified with belts and irregular nodules or masses of gray limestone	15 f
No. 3.	Green shale	1 f
No. 4.	White sand, varying to green shale	1½ f
No. 5.	Green clay	2 f
No. 6.	Calcareous shale, or marl, with some argillaceous matter	5 f
No. 7.	Green shale, or clay, with blotches of red, seen	1 f
	Total	25½ f

The same kind of greenish marl is exposed up the War ju, the immediate bluffs being somewhat wrought in it, to point just back of New Ulm, where the bank is opened b Mr. Winkelmann for laying pipes to supply his machine and brick-yard. The trench which he has dug pass through it just before reaching the bank of the Waraju riv The flat on which New Ulm stands seems to be made up a terrace wrought in the Cretaceous. The surface of t flat is strewn with boulders.

Another creek joins the Minnesota nearly opposite the mouth of the Waraju, and also affords such exposures of the Cretaceous limestone as to invite the construction of lime-kilns. The sections here seen are not so favorable as that of Mr. Winkelmann, and contain more shale, some of which shows also a red color. In the shale are crystals of selenite; exposed ten feet. The kilns at this place are owned by John Heiman and Francis Bausen.

On the Waraju, about three miles from New Ulm, Mr. Christian Dauffenbach has established a manufactory of fire-brick. He obtains the material from the left bank of the river, where the Cretaceous affords the following section:

Section in Cretaceous on the Waraju River:

No. 1.	Hardpan drift, made up of clay and stones, seen about...	30 ft.
No. 2.	White sand, the age of which is uncertain, containing irony concretions and deposits. It is somewhat indistinctly stratified obliquely, like drift sand, and has some coarse grains. Its position in reference to the overlying hardpan drift, together with its thickness and purely white color, indicates its age to be Cretaceous.....	100 ft.
No. 3.	Blue clay, containing some siliceo-calcareous, irony lumps; said by Mr. Dauffenbach to hold some coal, mixed with No. 4 for making fire-brick.....	4 ft.
No. 4.	Sandy marl, probably largely aluminous, pronounced a silicate of magnesia by the chemist of the Agricultural Department at Washington. It is white, and when long submerged, soft and fluid-like, but when dry has to be quarried by blasting. This, mixed at the rate of two-thirds, with one-third of No. 3, makes a fine white, fire-brick—seen.....	12 ft.
	Total hight of bluff.....	146 ft.

The above section varies in short intervals. In connection with others seen at New Ulm, it shows how careful geologists must be in attributing to drift all that is found before striking the indurated rock.

Under the guidance of Mr. Dauffenbach, about half a mile further up the river, a sandstone outcrop was encountered. It rises in a bluff immediately from the water, on the opposite side of the river. In this sandstone, which here appears firm and massive, and which is probably the equivalent of No. 2, of the foregoing section, are many irony mud balls, or concretions, having a fancied resemblance to plums or bananas. They vary in shape and size. They have been gathered as fossil "fruits," and sent east as rare curiosities.

The general section of the Cretaceous at New Ulm, is follows:

No. 1.	Drift, gravel and boulders, with a surface-loam in some places, or largely made up of sand.....	10 to 20
No. 2.	Fine clay, blue, bedded, weathering white, used for pottery or brick.....	4 to 10
No. 3.	Sand or fine gravel, not cemented, readily crumbling, containing magnesian balls, or rounded lumps made up of a fine white powder—seen.....	20 to 30

The conspicuous Cretaceous terrace that occurs along t Minnesota at New Ulm, is due to this fine crumbling san overlain by a more tenacious clay or shale. The varyi composition of the Cretaceous makes it difficult to establi the horizontality of different outcrops, but there cannot much doubt that No. 3 above is the equivalent of No. 2 the section on the Waraju.

In the southwestern part of T. 110, R. 31, is another i portant exposure of the Cretaceous. It is in the banks the Waraju, and consists of blue clay, and is used by t potters both at Mankato and New Ulm. That which most highly esteemed is taken from the right bank abo 40 feet above the river. It contains no gravel, nor a perceptible grit. It is owned by Silas Barnard.

A trial was made by Mr. H. B. Kaufer, potter at Ma kato, of a clay outcrop on the other side of the river, abc a quarter of a mile further up. Although this is about t same altitude above the river, and has outwardly the sa general color and character, it is said to have proved u for potter's use, owing to the occurrence of small, bla hard, roughened pebbles, that can be broken only w great pressure, called "sulphur balls." These small spec weather black, and are doubtless composed of crystall sulphuret of iron.

At Sleepy Eye, T. 110, R. 32, the Winona and St. Pe R. R. Company are sinking a well for artesian water. the depth of 143 feet the drill had passed through the lowing section:

Black loam.....	5 or 6 fe
Gravelly, brown clay.....	20 feet.
Gravelly, blue clay.....	115 feet.
Soft, pulpy, blue clay, that necessitated the tubing of the well.....	3 feet.
Total depth.....	143 feet.

In sinking a former drill, a pocket of coal was met in gravelly, blue clay, at the depth of 75 or 80 feet.

The Cretaceous again occurs in the banks of Little Rock creek, near Fort Ridgely, and was at one time explored there for coal.

At a point two miles below the Lower Sioux Agency, Sec. 10, T. 112, R. 34, on the north side of the Minnesota, a small creek joins the river. Up this creek, about three-quarters of a mile from the river bluffs, the Cretaceous appears in its banks. A concretionary marl, or apparently limy earth, of a white color, crumbles out under the projecting turf. It appears in fragments of an inch or two, or sometimes larger, with angular outline. The surfaces of these pieces show a great number of round or oval spots, or rings, which seem to be formed by the sections of concretions inclosed in the mass. It is rather hard when dry, and nearly white. It is associated with a blue clay, the relations of which cannot here be made out.

At a point a little further up this creek appears a heavy deposit of concretionary, rusty marl, or ferro-calcareous substance, the exact composition and proper name of which it is impossible to give, before it has been chemically examined. It is in heavy beds, that fall off in large fragments, like rock. The first impression is that the bluff is composed of ferruginous conglomerate, but there is not a foreign pebble in it. Every little round mass has a thin shell which is easily broken, revealing either a cavity or a loose, dry earth. These concretions are generally not more than 1-4 or 1-2 inch in diameter; seen 18 feet. Under this is the light, concretionary clay or marl already described.

At the Lower Agency an exposure of the Cretaceous occurs in the road, seen in descending to the ferry. It consists of a sandy marl. Beds horizontal, or nearly so.

In the banks of Crow Creek, which enters the Minnesota 3½ miles below Redwood Falls, the Cretaceous beds are carbonaceous, and have been considerably explored for coal, on the land of George Johnson. In 1871, Wm. H. Grant, of St. Paul, entered upon a systematic examination of these layers, drifting into the side of the ravine 200 or 250 feet. This work is said to have cost about $2,000. A similar "coal mine" was opened in the banks of the Redwood, near Redwood Falls, where $5,000 are said to have been expended in a like fruitless attempt. This coal is from one of those layers in the Cretaceous that are usually known as lignites. It is earthy, passing sometimes into a good cannel coal, or into a bituminous clay. The compact cannel coal is in detached lumps, and occurs throughout a band of

about four feet in thickness. This lignitic band was followed in drifting into the bank of Crow Creek, and was found to divide by interstratification with black clay, showing some leafy impressions and pieces of charcoal.

The "coal" here is said to overlie a bed of lumpy, concretionary marl, similar to that described at two miles below the Lower Agency, or two and a half miles below Birch Coolie. In some of the concretions are small shining balls of pyrites, which the workmen treasured up as gold. Over the "coal" is a blue clay, requiring a timbered roof in the tunnel. This clay is likewise Cretaceous. The underlying lumpy or concretionary white marl becomes siliceous, or even arenaceous, the concretions appearing more like chert. Some of it is also pebbly, showing the action of water currents.

The same lignitic coal occurs near Mr. Johnson's, on the land of Hugh Curry, Wm. H. Cornell, E. O. King and Mr. Riker's, in the little ravines that enter the Minnesota, the exposures being kept fresh by the freshet waters. More or less exploring and drilling, besides that done by Mr. Grant, has been engaged in, in this vicinity, but never with any better success.

Near Redwood Falls, on land of Mr. Birney Flinn, another outcrop of carbonaceous deposit in the Cretaceous. This is seen in the left bank of the Redwood river. It is the form of a black bedded clay or shale, five or six feet thick, more or less mingled with charcoal and ashes, the whole passing below into charcoal fragments mixed with the same ash-like substance. In the latter are sometimes large pieces of fine, black, very compact coal, the same as that already spoken of at Crow Creek, as cannel coal. These masses show sometimes what appears to the eye to be fine woody fiber, as if they, too, were simply charred wood. Further examination will be needed to determine their origin and nature. They constitute the only really valuable portions of the bed, the light charcoal, which everywhere shows the distinct woody fiber, being generally mixed with the light ashy substance, and in a state of fine subdivision.

A short distance above Mr. Flynn's land is that of George Houghton, where the Redwood Falls Coal Mine was opened.

This mine consists of a drift into the bluff, forty feet, following a lignite, or charcoal bed in the Cretaceous. The bed here is seven feet thick, the greater part of it being made up of black, bedded shale or clay, though Mr. Flynn is authority for the statement that it showed a great deal

more of the real charcoal than any other point discovered. Some fragments that lay near the opening, contained about nine parts of light charcoal to one of ash, the whole very slightly cemented, and so frail as to hardly endure transportation. In this drift were also numerous pieces of what is described by the owners both here and at Crow Creek, as "stone coal." It is the same as that mentioned as probably a cannel coal, occurring at Crow Creek. It is these harder lumps that is found scattered in the drift throughout the southwestern part of the State, so often mentioned in the newspapers.

Up a little creek that comes into the Yellow Medicine river from the south, near the village, is an exposure of fine stratified blue clay that weathers to a yellowish color. It has a thickness of at least ten or fifteen feet.

At a point six miles below Montevideo, on the north side of the Minnesota, there is a terrace within the main river bluffs, extending along the river for three miles at least, on which there is a wide plateau. This terrace rises 45 or 50 feet above the water, the flood plain being about 12 feet. On examining for the cause of this terrace, the only indurated rock found was in a little point that juts out toward the river about on a level with the top of the terrace; and that consists of granite, overstrewn with boulders. The terrace, however, is probably not due to underlying granite, for the surface of granite would not be so nearly level as to give the uniformity and regularity of outline here seen. It is more likely that Cretaceous rock, of a fragile and crumbling character, is concerned in giving form to this terrace, as has been seen in a number of other cases.

A mile further up the river, this bench shows a fresh section down to the water level. In general, the whole consists of fine sand, in which swallows burrow and breed. It stands, however, in nearly perpendicular walls, something like the "bluff." Yet it is not the *bluff*, because it is too fine, has no shells nor pebbles, and is stratified. It also becomes a bright blue color near the water level, and shows a stickey, clayey consistency, indicating a good material for brick. It cannot be of the same date and origin as the *bluff*, since it is an isolated instance of the occurrence of such beds along the Minnesota valley. It has very much the character of a late alluvial deposit, but rises too high to be of the same date as the flood-plain of the river. It is throughout mainly sand. The sedimentation is not always horizontal, if the individual layers be regarded separately, but it is if

taken collectively. There is a wave-like arrangement or anastomosing of layers; some are quite oblique and cross-bedded. In some parts of the upper 25 feet there is a rustiness, confined to certain thin beds, which makes them adhere in masses after falling out of the bluff, and at a distance have something of the appearance of sandrock. These, however, crush down at once under the hammer, or even in the fingers. While this deposit has very much the aspect of fine drift, its occurrence here in the form of a wide, continous plateau, rising nearly fifty feet above the water, makes it very probable that it belongs to the Cretaceous, although it differs from any rock of that age before seen.

About half a mile, a little west of south from the stage station at the head of Big Stone Lake, in Dacotah, an exposure of Cretaceous occurs in the right bank of the upper Minnesota. It shows superficially only a weathered, sliding talus of shale, which is black and somewhat slaty, but which on digging becomes moister and soft and somewhat flexible yet parting into small chips. Over the surface of the ground where this shale outcrops, the turf is prevented from growing, and two conspicuous objects, weathered out from the shale, are seen. 1st. Little angular crystals of pure gypsum, the largest seen weighing not over half a pound. 2d. Little angular bits of yellowish red ochre, that are hard and thin, but can be cut with a knife. There is also an occasional piece of brecciated, clayey, or at least aluminous rock, the cracks and surfaces of which are filled and coated with crystals of calc-spar. When broken by the hammer, the part along the numerous planes that on either side are lined by this calc-spar, and each fragment is entire, appearing itself a mass of calcite. It is only by several attempts that a view of the interior, on which these coatings are formed, can be obtained. The thickness of this shale bed cannot be ascertained. The angular bits of ochre are most numerous near the top, where the drift supervenes, but the gypsum crystals are scattered over the whole outcrop. The indications are that the gypsum and ochre are embraced within the shale, and become superficial by weathering. The whole may be twenty-five feet thick.

This shale bed is the cause of a terrace in the descent from the high prairie, and of numerous springs that issue below the drift, about sixty feet below the prairie level. These springs excavate narrow ravines and "gulches" in the shale, the whole being smoothly turfed over, except a

the point above described. These alternating gulches, and the intervening short pieces of the remaining terrace, make the bluff in general appear hilly, in its ascent from the bottom-land. These ravines, in the wet season of the year, are very soft, and since they appear practicable for a horse, are the cause of many misfortunes to the traveler. Many such treacherous, springy places are described as occurring along the shores of lake Travers, at some elevation above the waters of the lake. The same rolling ascent from the bottom-land to the high prairie can be seen also at the head of Big Stone Lake, on the Minnesota side, and it is there doubtless, due to the same cause.

General Section of the Cretaceous in Southwestern Minnesota.

The limited observations that have been made on the Cretaceous in Minnesota, will not warrant a conclusion on the alternation of parts described in the foregoing account of the Minnesota valley. The beds are nearly horizontal everywhere seen, a fact which makes it necessary to pass over long intervals before looking for a change in the observed horizon. While this simplifies the problem, it leaves out of the account the possible changes that may exist in the character of the sedimentation on any geological horizon, and introduces an element of uncertainty in any attempt to generalize the rocks of the Cretaceous. Future observations made in detail in the various counties crossed by the Minnesota and its tributary valleys, will throw very much light on the question of the supposition of the outcropping members that have been seen the past season. The following arrangement is altogether provisional, and is intended to express such superposition as seems to be correct, in the light of the information now at hand.

In descending order.

1. Shale holding gypsum. Big Stone Lake.
2. Clay and lignite clay. Crow Creek and Redwood Falls.
3. Concretionary marl. Sec. 10, T. 112, R. 34.
4. Potter's clay. New Ulm and T. 110, R. 31.
5. Dauffenbach's fire-brick section. Waraju river, (perhaps the sandstone seen near Red Jacket Mills, and at Garden City, belongs here, (p. 133.)
6. Limestone and shale. Winkelmann's quarry, near the mouth of the Waraju river.
7. Sandy shale. Gruebel's section, Sec. 2, T. 109, R. 30.
8. Sandstone. Fritz's quarry, Sec. 16, T. 109, R. 29.

(k) *The Drift, and the general Topography of the Valley.*

Southwestern Minnesota is characterized by extensive drift deposits. They are spread so evenly over the whole country, that to the eye of the traveler, there are but few important variations from a dead flat. One vast plain seems to spread out on all sides. The view is only obstructed by the narrow timber belts that skirt the valleys of streams, or by the dim haze in which the horizon is itself lost to sight. There are minor irregularities of surface due to the occurrence of gravelly knolls, and to the erosion wrought in the surface by streams of water, but these do not affect materially the general flatness of the whole region.

The general composition of the drift is such as to prove its origin to have been due to glaciers. By far the largest part consists of "blue clay," the surface of which is weathered to a yellowish brown to the depth of 15 or 20 feet. This contains gravel stones and boulders, yet it is nearly, and often quite, impervious to water. There are places, especially along the immediate valleys of the principal drainage courses, in which the drift shows a very sandy and gravelly composition, the sand and gravel being deposited in oblique and vanishing layers, often to the depth of over fifty feet. This character is very common along the Minnesota from Mendota to Mankato. In this case the main bluffs of the river, constituting the principal, and the first, descent from the prairie level, are made up of such stratified deposits, but at a short distance from the river valley in either direction, the typical unmodified glacier drift returns with its full development.

Besides these instances of stratified gravel and sand in the drift along the immediate river valleys, isolated knolls or clusters of knolls, composed of the same materials, are sometimes seen rising boldly and conspicuously from the midst of the level prairie, reaching all hights up to a hundred feet or more. Such knolls are sometimes ferriferous and the gravel is hardly cemented, making a crag, with lumps of impure bog-ore. This ore is not now properly a bog-ore, since it lies on the sides of gravel knolls, one or two hundred feet high, (as on the Maple river, near the Red Jacket Mills,) but it is probably a brown Haematite. It is very siliceous and not likely to be of economical value. These gravel knolls are sometimes very stony, with northern boulders. Instances of such gravelly, rolling tracts sometimes of large extent, were noted in the reconnoissance

made the past season, as follows: A belt of gravelly knolls runs from the southeast part of Faribault county, to about the center of the same. South from Lura it may be seen across the treeless prairie, and is scantily wooded. It furnishes the only stone useful for building or for foundations, in the form of northern boulders, that can be found throughout a wide extent of country. This gravel belt rises considerably higher than the village of Wells, and probably gives source and head to the artesian overflow of water that there exists. These artesian wells are 115 feet deep, and passed through "blue clay." In about the center of T. 110, R. 32, is a gravelly ridge or succession of drift knolls, running NNW., showing boulders on the surface. The country about is flat and prairie like, covered with the hard-pan, glacier drift, and these knolls are quite a relief to the eye. One can hardly resist the conviction that rock *in situ* must occur somewhere exposed in these knolls, and it is only after a lengthy examination that their true character is established. This ridge runs about a mile east of Sleepy Eye village, and the separate knolls rise 25–40 feet. They lie about on the strike of the red quartzite from New Ulm. The eastern ascent of the Coteau des Prairies enters Minnesota from the NW., in the southwestern part of Yellow Medicine county. East of this ascent about ten miles is a range of gravel hills running nearly N. and S., known at their southern extremity as the "Cobble Knolls," and at their northern as the "Antelope Hills." They are composed, as their name indicates, of drift. They have a general extension N. and S., but yet they occur in clusters. Some are quite sharp and abrupt. They rise from 125 to 200 feet above the surrounding prairie. They are smoothly rounded on their summits, and overstrewn with stones and boulders—the latter showing frequent glacial surfaces, even on the top. The grass and weeds are short. The soil is thin. Little gravel stones almost cover the surface. The knolls themselves consist largely, without doubt, of stratified gravel and sand, like a great many others that have been seen in different parts of the drift latitudes, (*Geol. of Iowa*, 1870, *Vol.* 1, *p.* 99; *Geological Survey of Ohio*, under Hardin, Allen, Delaware and Anglaize counties; *Proceedings of the American Association*, 1872, *p.* 164.)

They can be seen to extend six or eight miles, and perhaps are traceable further than that distance. From their tops a magnificent view of the prairies on all sides, and of the Coteau toward the west, can be had. A similar range

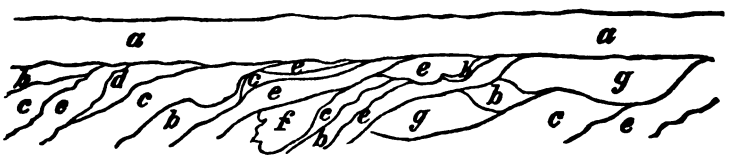
of drift knolls, but much smaller, was seen about six miles east of this range, running also in the direction N. and S. For reasons that cannot be here enumerated, these gravel ridges are believed to mark the location of the strike of different formations of rock, which, with each other, formed such inequalities in the surface passed over by the great glacier as to fracture the ice profoundly. The streams of water that entered and ran through such cravasses were sufficiently powerful to wash out the clayey portions of the drift, and to arrange the coarser in various stratification. After the withdrawal of the ice, the ridges of gravel mark the general location of such glacial streams. These must not be confounded with other drift ridges that accumulated about the borders of the ice-field, known as moraines, of which the Coteau des Prairies seems to be a stupendous example. This remarkable topographical phenomenon was visited at the point where the Winona and St. Peter R.R. meets it. The country from Lac qui-Parle to that place is of the same general character as the rest of Southwestern Minnesota, but is perhaps freer from sloughs and impassable places than the country in the region of the Silurian rock. It is mostly entirely destitute of timber. The Lac-qui-Parle and its tributaries are wooded a few miles from the Minnesota, but very sparsely. The timber entirely disappears before reaching the state line. The soil shows in dessicated places the color of the alkaline deposit common on the western plains, becoming more and more abundant toward the west. There is not, enough, however, in this direction within the state of Minnesota to interfere seriously with agriculture or stock raising. The productiveness of the soil seems not to be affected by it. The state line, where the Winona and St. Peter R.R. passes it, is a short distance west of the foot of the Coteau. At a distance the Coteau looks like a sudden and marked elevation in the western horizon, rising a great hight above the prairie level. But on reaching it the ascent is found to be gradual, the surface changing from level to rolling or hilly. It is, however, quite abrupt in some places. Good farms can be laid out in nearly all parts of the Coteau, many of them far preferable to farms very highly valued in Ohio, Pennsylvania or New York. There is no timber except along the tributaries of the Lac qui Parle, or other small streams. No rock can be seen *in situ*. Although the railroad affords very frequent cuts in getting through this rolling country, it discloses no known rock as far westward as Lake Cam-

peska. This point was particularly examined for over six miles beyond the foot of the Coteau, with the hope of seeing, in some of the frequent cuts, some indication of a rocky substructure. Nothing can be seen but drift. This drift consists of glacial clay. The surface is generally stony, especially onthe tops and brows of knolls. Boulders of northern origin are very common. Some large fragments of Silurian limestone were seen, but generally the erratics are granitic. Beyond the first ascent to the knobs of the Coteau, there is a stretch of less rolling country reaching westward about ten miles, when another still higher range of hills and bluffs appears. The divide, east of the Sioux river, is about fifteen miles west of the state line, at an elevation (by the Winona and St. Peter R.R.) of 1,448 feet above Winona. The ascent from the prairie level, a few miles east of the state line, to the top of the Coteau, fifteen miles west of the state line, is about 650 feet. On the top of the high country are occasional pleasant lakes. At De Graff, just beyond the state line, in Duell county, Capt. H. H. Herrick burns lime from a dark surface deposit of tufa. This deposit shows impressions of leaves and twigs, and others that appear like rushes. It has some iron stains, and a trace of bituminous matter. It occurs in a number of places on the sides of the knolls, overlying the drift gravel and clay. The general appearance of the surface of the Coteau, especially near its base, as well as the surface of the Antelope Hills, aside from this surface deposit of tufa, where no water is now running, indicates the former prevalence of a much greater amount of water running over it than now. The boulders and gravel that lie so thick on the top and upper slopes came from the drift, the clayey parts having been carried away by drainage. They are all water worn—though not so but that the boulders sometimes show glacially striated surfaces. That this water was running, and not standing, is evidenced by the tufa, which is only deposited where the atmosphere has access, and by the manner of its occurrence, which is only on the lower slopes of the knolls, though at varying elevations, so far as seen. That there was vegetation near is proved by the leaves and other impressions. That the flow was of short duration, comparatively, is also proved by the universality and uniform character of the drift sheet, and by the lack of rocky outcrops. That the water which deposited the tufa was heavily charged with lime, is proved by the abundance of the deposit and by the coarseness of

the inclosed impressions. That it was the same that washed the light drift from the tops and brows of the knolls, is evident from their associated occurrence. That this water was from the retiring glacier, which would inevitably have given off water of a milky color, stained with the fine debris and soluble portions of the rocks it had ground up in its course, is probable.

At St. Paul, near the St. Paul and Sioux City depot, the lower part of the drift is exposed in the excavated river bluff, and is chiefly hardpan clay (or glacier drift.) It is conspicuously colored by the shale of the Trenton. The alternating blue shale and copper-colored hardpan drift show successive accretions with such regularity as to attract immediate attention. The bands slope at an angle with the horizon, the drift holding stones and occasionally large boulders, and the shale showing fragments of the bedded lamination not yet obliterated, as well as the usual fragments of *Chaetetes*. At a higher level is a heavy stratum of 25 feet, overlying the foregoing, consisting of gravel and boulders, with many pieces of limestone. The following diagram illustrates the alternation of materials in the drift at this place.

Section in the drift at St. Paul.



Explanation.

a. Gravel, with many stones, 25 or 30 feet.
b. Green, shaly clay,
c. Blue, shaly clay,
d. Greenish, shaly clay,
e. Red clay,
f. Brown drift clay, stony,
g. Ashen drift clay,

25 feet above the river; } 25 or 30 feet.

The bluffs of the Minnesota require a special mention, as they form a very important element, not only in the topography of the southwestern part of Minnesota, but also in any description of the drift of that portion of the state and of the northwest. The level of the river itself, in the summer season, is about 180 feet below the prairie level. The water runs in a very winding course back and forth between

the bordering bluffs, the direction of which, not regarding the little angles caused by streams that enter the Minnesota, is very regular. They have some long bends, but in general maintain a remarkable constancy of direction and hight. The bluffs, especially on the north side, are often treeless. The bottom-land itself is very often treeless. On the south side, on the contrary, the river bottoms and the tributary valleys, as well as the slope of the main bluff, are usually wooded. Hence the abruptness, and at the same time, the regularity of slope, direction and outline, are most marked on the north side. These bluffs appear, superficially, to be formed of drift alone above Mankato.

Below Mankato the Silurian rocks are frequently seen exposed in them, causing long terraces at various altitudes. Throughout the whole length of the valley, boulders and stones of a northern origin are seen on the brows of these bluffs, and on their abrupt faces, or on the slopes themselves. They literally cover, sometimes, the Silurian terraces below Mankato, as at Shakopee, Louisville, Ottawa, St. Peter, Mankato and Judson. There is a good illustration of this in the terrace that extends along the east side of the river below Mankato, and also toward South Bend. Where the hard rocks of the Silurian lie deeper, the boulders that otherwise would be visible seem to have sunk into the softer alluvium. They are always met with in penetrating through the alluvium, before striking the rock. They pertained to the general sheet of drift, before the excavation of the valley, and have been left simply lodged where they may have fallen, sometimes on rock terraces, as the river has slowly carried away the fine clayey portions of the drift. Notwithstanding the drift characters are the only apparent ones, yet there is a canopy of Cretaceous that lies below and gives levelness to the country, hiding the granite and the Silurian rocks. This, mixing with the drift, has greatly augmented its volume beyond what it would have been had harder rocks existed in western and southwestern Minnesota. The existence of this canopy of Cretaceous under the drift is demonstrated by the occasional exposure of such beds in the little ravines that enter the Minnesota. Such beds are intersected by the bluffs themselves, and cut by the river channel, though they are rarely seen in the main bluffs of the river itself. They are hid by the downfalling of the drift. They are so frail themselves that they cannot endure the exposure exhibited by the Silurian limestones, (see page 184,) and hence do not make

so manifest terraces in the main bluff. This main bluff, therefore, above Mankato, generally exhibits a regular slope from the prairie to the bottom land. There is sometimes a dim outline of a terrace, or shoulder, in this slope, caused by the unequal demolition of the Cretaceous, but *throughout the valley there are no alluvial terraces that can be attributed to successive reductions in the volume of the river.* Such appearances are visible at New Ulm, as well as at various places below Mankato, at Lower Sioux Agency and at Beaver Falls. At places below Mankato the semblance to constant terraces is due to the effect of the Shakopee Limestone on the banks, combined with that of the erosible nature of the underlying Jordan Sandstone. Such occasional benches occur at different elevations as far as the Silurian rocks extend. Above that they are due to the Cretaceous. Such occur at Fritz's quarry, a few miles below New Ulm, and at Gruebel's a little further up the river. At the former place a sandstone in the Cretaceous offers a more persistent obstruction to the water, at the latter the terrace is caused by a hard clayey layer over one that is soft and arenaceous. At New Ulm a similar combination of layers may be seen near Dauffenbach's pottery, and in some of the highway cuts for grading the streets running down from the city (which is situated on this terrace) to the R. R. depot. At and below Redstone, and on the opposite side of the Minnesota near the mouth of the Waraju river, a calcareous member of the Cretaceous causes a terrace that rises about 40 feet above the river. This may be seen at Winkelmann's lime kiln and quarry. This terrace is prolonged for several miles below Redstone, on the north side of the river. Its level for some distance is kept up by the red quartzite in outcrop there, but it is doubtless due mainly to the Cretaceous.

At Lower Agency a dim outline of a terrace is seen near the top of the bluff running along about half a mile. Its cause is not discoverable, but may be reasonably regarded some member of the Cretaceous, which can be seen at a lower level in the highway ascending from the ferry to the top of the bluff. It is most observable from a distance, and especially from the north side of the river.

There is a semblance at Beaver Falls, though faint, of two terraces, near the top of the bluff, visible from the opposite side of the river, the upper one having about the position of the faint terrace seen at Lower Sioux Agency.

A terraced condition of the bluffs may be seen at a little lake, caused by the enlargement of the river on T. 120, R. 44, as well as in the bluffs of Lac-qui-Parle. Here an observation was made that plainly indicates the origin of these benches. They exhibit a slope or dip toward the S.E., running successively down to the bottoms, higher ones occurring in their places. This can plainly be seen from the opposite bluff. This slope is believed to be due, in like manner, to the dip of the rocks of the Cretaceous, though no outcrop of those rocks was seen at that place, the bluffs of the river and of all ravines being smoothly turfed over.

The general hight of the bluffs that enclose Big Stone Lake is about 150 feet. They are treeless. Their crests are usually crowned with boulders. The only wood that is seen lies in the "gulches" or short ravines that enter the lake from both sides, and on the islands, some of which are densely wooded with small trees. There is also a thinly continuous row of small trees and shrubs growing on the immediate shore, just above the boulder-row. The bottom-land is usually not marshy but arable, constituting really the most desirable farms. It is first taken by settlers. It is wide enough for one or two good fields. The settler also has his garden and cabin on the low land invariably, and generally at the opening of some one of the little ravines, which afford water without digging*, and protection from the winter winds, as well as convenient fuel. Along this lake, also, are terraces that have a slope or dip striking across the bluffs. One may be seen at Mr. Hurley's, eight miles above the foot of the lake, where it can be traced three or four miles, passing, in that distance, down from union with the prairie level to the bottoms, or so far down as to be blended in the bottom land. A similar vanishing terrace can be seen on the Dakota side, from the bluff on the north side, about twelve miles above the foot of the lake, and midway between Hurley's and Mireau's. Within the space of about three miles, its form can be seen to pass obliquely across the face of the main bluff, from top to bottom, sloping to the east or southeast, and disappearing in the bottom-land. A similar terraced appearance has been described as occurring at Brown's valley, at the head of Big Stone Lake, in connection with an exposure of the Cretaceous (see p. 190.) The interval between Big Stone Lake and Lake Travers (6 miles) has a fall toward Big Stone Lake of six feet. The bluffs approach each other toward the end of the lower

*The water of the lake is clear and apparently deep.

lake, but do not unite. A continuous valley, between bluffs of the same form and appearance, and of nearly the same depth, connects the two lakes, giving the impression of one valley instead of two. The short interval constituting the divide between the two lakes is usually without water, but is often overflowed by the spring freshets, when a continuous overland watercourse is established between the Gulf of Mexico and Hudson's Bay, in British America. It was on one of these occasions that the attempt was made by the late Hon. Joseph R. Brown, to float a steamboat from the Mississippi to the Red River of the North. Its remains still lie a few miles below the foot of Big Stone Lake, where it was wrecked by the unexpected subsidence of the water. There is a very perceptible ascent in the smooth surface of the prairie, toward the north, from the bluffs of Big Stone Lake.

Several points have been mentioned at which local terraces have been seen along the valley of the Minnesota river. They are occasioned, as has already been said, by the varying resistance of the underlying rock, when undergoing erosion by the river. This is evident from the following facts:

1st. They have a varying elevation, corresponding with the dip of the formation which causes them. They occur near the level of the flood-plain, blending sometimes with it, and also at all hights, to near the top of the bluffs.

2nd. The rock itself can be seen at many of the places where such terraces have been observed; and where it has not been seen, the face of the bluff has been unfavorable for exposure, the surface being smoothly turfed over.

3rd. There are hundreds of miles along the river, on both sides, where no such terraces can be seen, the bare bluffs being smoothly rounded off, and descending at one change from the prairie level to the flood plain. Indeed, the existence of terraces is quite an exceptional thing.

4th. In many cases, the terraces can be referred directly to their cause, layers of varying resistance in the Cretaceous.

5th. Where there is no rock in the river banks, as shown by fresh slides, there is no appearance of terraces.

A short distance below Minnesota Falls the bluff rises, on the north side, 159 feet 1 and ¾ inches above the flood-plain, measured by Locke's level.

There is an old valley of the Minnesota river, extending from Lac qui-Parle lake eastwardly, and joining the Chippewa valley about five miles above its mouth. This old valley has bluffs like the present river valley, but it is not

quite as deep. It is nearly dry, a little water standing only in one or two spots, near the west end, and slowly passing into the Minnesota, the bottom being a level and handsome meadow. The appearance of this valley is rather novel and striking. The slopes are perfectly treeless, and very smooth, luxuriantly covered with grass and ornamented with flowers of various colors. There are short ravines or "gulches," that descend from the prairie, but they do not show a tree, nor a shrub. They are smoothly grassed over, and near their mouths can be crossed with a team. The bluffs themselves, though often overstrewn with stones and coarse gravel, are yet composed of hard drift clay, and are rarely too abrupt to be ascended by a horse. Toward the west end of this old valley the slope from the prairie shows a terrace about thirty feet from the top, but nothing can be seen on it, or even in the excavation cut for the road, but drift materials, though boulders are rather more numerous at that point in the cut than above or below. Below the level of this bench, twenty feet, is a row of springs which keep the rest of the slope wet and soft. The whole appearance, taken together, indicates a stratified condition of the bluff, probably in Cretaceous rock.

THE ECONOMICAL GEOLOGY OF THE MINNESOTA VALLEY.

Coal.

The separation of the region of the Minnesota valley from all the important coal fields, and its comparatively sparse supply of wood for fuel, have directed the attention of the settlers to the possible supply of fuel from the lignites of the Cretaceous. Mention has already been made of the localities of outcrop of this coal, (pp. 221–224,) with some description of the modes of its occurrence. The subject has also been summarized in the letter to the President introductory to this report. There are coal deposits of the Cretaceous age that are likely to prove valuable. They occur at various places, scattered over the western territories. Such coal is also sometimes in the condition of good anthracite. A valuable bed of coal is reported to exist a few miles west of Bismarck, on the Missouri river. There can be but little doubt that such or similar coal accompanies the lower Cretaceous rocks throughout their extent in Minnesota. From the wide extent of territory in which "float coal" is found in the drift, it seems very probable that the Cretaceous

ocean at first covered the most of the State. So far as discovered, however, there is not enough coal embraced in the Cretaceous, in this State, to warrant sanguine expectations of its becoming economically useful. This coal occurs in in two distinct forms, which may be distinguished, until further investigations demonstrate some error in the designations here given, as *charcoal* and *cannel coal*. The former, while it is the more abundant, is of less value for use as fuel. It is light, and quickly ignites, but it is generally in fine pieces that appear to be matted down with the ash that resulted from the combustion of other portions of the wood from which the coal is derived. It lies in irregular sheets generally, not more than half an thick when pure, but may be desseminated through a thickness of six or eight feet. It is very fragile, hardly bearing transportation. The latter is black, or brown-black, lustrous, compact, rather hard, and presents every aspect of a valuable coal. It occurs in isolated lumps or pockets, in the same beds as the charcoal, but less abundantly. It readily burns, making a hot fire. In the air, when it has become dry, it cracks and crumbles something like quick lime, but not to a powder. It is this which is found in the drift. If it could be found in sufficient quantity, this would be a valuable fuel.

The Iowa coal field, of Carboniferous age, does not reach as far northwest as the valley of the Minnesota.

Iron.

The only iron ore that is known to occur in southwestern Minnesota, is in the form of an imperfectly hydrated peroxyd, or brown haematite. It is, so far as seen, so impure as to constitute a clay iron-stone. It was first mentioned as occurring on the Le Sueur, a mile and a half above its mouth, by Dr. B. F. Shumard, (Owens' Report, p. 487), who describes it as "nodules of oxide of iron, and argillaceous iron ore," and gives it a thickness of two feet, remarking that: "The superficial indications render it probable that this bed of iron ore may be both extensive and readily accessible." Similar indications of iron ore were seen the past season at a number of places on the Le Sueur and on the Watonwan. So far as observed, however, the iron seems to be largely, if not entirely, superficial, and pertains to the horizon of separation between the drift and the bedded rock. It is a circumstance of frequent occurrence, in all parts of the northwest, to see ferriferous

springs issuing from the gravel of the drift. When such water comes in contact with the air it invariably gives an irony stain to substances over which it runs. If the process be continued a brown haematite iron ore will be formed. It will partake of the impurities of the surface on which it forms. There is besides a considerable thickness of argillaceous iron-stone that coats the Silurian limestones, when they are found overlain by the clays of the Cretaceous, (see pages 133 and 179.)

Mineral Paint.

At Redwood Falls the kaolin which has resulted from the decomposition of the granitic rock, has become stained with iron, and has a brownish or greenish-brown color. It contains, generally, some silica. From this stained kaolin a good mineral paint has been manufactured. Messrs. Grant and Brusseau commenced the enterprise, and carried it far enough to demonstrate the quality of the product. The manufactured article is said to have been equal to that of Brandon, Vt., but the cost was so great that, after transportation to St. Paul, it could not be offered in the market so cheaply as the Brandon paint. Their process was very simple. The raw material was obtained from the banks of the Redwood river (p. 168), and was of a rusty-brown color, having also a greenish tinge. It was broken, or crushed to the fineness of corn or wheat. It was then dried in a large pan placed over a fire, and ground by water-power, between two burr-stones. In that condition it was ready for use by simply mixing with boiled or raw linseed oil. It was found that lead or ochre could not be used to advantage with it. The lead is said to have "come out and looked like a mildew." The color produced was a reddish umber. By making some selections various lighter shades, of the same general character, were produced. It had a heavy sediment, consisting probably of iron and silica. The quality of the paint is said to have been superior to that from Ohio, and fully equal to that from Brandon, Vt., or Horicon, Wis. The surface of the wood painted, becomes hardened and glazed, but remains smooth.*

It is evident that the best methods for economy were not employed in this enterprise. The mine is situated about a mile from the mill. The rock is easy of access. It cost a

* The mills of Worden, Ruter & Co., at Redwood Falls, and of Austin & Worden, at Minnesota Falls, are painted with it.

sum between three and four dollars per ton to deliver the raw material at the mill. It could probably be done for less than a dollar. The total cost of manufacture ought not to exceed a dollar per hundred, or twenty dollars per ton. The Brandon paint sells for about $40 per ton. These statements are on the authority of Mr. Park Worden, of Minnesota Falls.

Although the foregoing is the only systematic attempt that has been made to manufacture paint from this substance in the Minnesota Valley, it occurs in great abundance at a number of places. It is also found in greater purity, at least with much less quartz and iron, at several other places. Indeed it seems to exist wherever the granitic rocks were buried beneath the ocean of the Cretaceous age, and where the glacier period has not disrupted it.

Quick-lime.

For common quick-lime the region of the upper Minnesota has no suitable stone. Here is a great extent of fertile country, destined to be thickly inhabited, that must always depend on the Silurian limestones, situated further southeast, for one of its necessary articles of construction. At the present time the only resort is to the limestone boulders that occur in the drift. These are being rapidly gathered up and converted into quick-lime, and will soon entirely disappear. The nearest Silurian quarries capable of being useful for quicklime are at Mankato. The limestone found in the Cretaceous at New Ulm is also very valuable to this region, but the shaly nature of the stone there will always make it difficult to compete with the lime from Mankato. At the same time the quality of the lime made there renders it applicable to uses of which the Mankato quicklime is not susceptible. The Mankato lime is of a dark leather color, slacking to a cream color. It has a considerable sand that appears as a sediment. The stone itself is an arenaceous magnesian limestone, and the lime partakes of the nature of those limes. It sets more slowly, burns more easily, and slacks with less heat than the pure limestones. It is useful for brick and stone work, but will not answer for hard finish. For common brown plastering it is very useful. The lime made at New Ulm, on the other hand, is nearly white, and in that respect has the advantage of the Mankato quick-lime. It is very hot, and sets quickly. It is more nearly a pure lime, without magnesia. While it

has no sand, as an impurity, it has alumina. Associated with it in the shales of the Cretaceous, is more or less of sulphate of lime in the form of transparent crystals, or selenite. When there is much of this it would materially affect the quality of the lime, giving it somewhat the character of plaster of Paris. Below Mankato there is no lack of good stone for quick-lime. The Shakopee limestone is calcined at a number of places, and outcrops in the banks of the river at a great many others.

At Shakopee the kilns are owned by Baptiste Contre and Isaac Lincoln. They are constant, or "draw kilns." Mr. Contre burns from 17 to 18 hundred barrels per month, and seven months per year. His markets are St. Paul, Minneapolis and St. Cloud, in bulk, two hundred pounds making a barrel. Lime is produced in 30 hours. Wood costs two or two and a half dollars per cord, mixed. He "draws" every six hours.

Mr. Lincoln's kiln is considerably larger than Contre's, and requires from two to four days to produce lime, which sell at the kiln at 75 cents per barrel, twenty-two or twenty-four hundred barrels being produced per month, during seven or eight months of the year. The lime made at Shakopee is of a leather color, sometimes approaching burnt umber.

At Louisville, five miles above Shakopee, Mr. Contre owns another kiln similar to that at Shakopee. Mr. Folsom, of Minneapolis, also has a kiln here which is in operation some portions of the year. The lime produced here is of the same character as that at Shakopee. It is shipped to St. Paul, Minneapolis, and occasionally to Duluth and St. Cloud. Four or five cords of mixed wood, at two and a half dollars per cord are required for each hundred barrels.

John P. Rinshed burns lime from the Shakopee stone, at Ottawa.

About a mile above Kasota Conrad Smith burns lime from the Shakopee limestone, which he sell at one dollar per barrel. Eight or nine cords of mixed wood, at $2.75 per cord, are consumed in producing 100 barrels of lime. He has a draw kiln, but not enough demand to keep it in constant blast. The lime is dark, and in nearly all respects like the Shakopee lime. It shows a bluish tint, and, Mr. Smith says, slacks to a *blue-white*, instead of a *yellow-white*, and is preferred for that reason.

Five miles below Mankato George C. Clapp burns a lime that is bluish, or ashen-colored. He takes the stone from

the upper portion of the Shakopee limestone, and produces a purer lime than any seen in the valley, except that derived from the Cretaceous at New Ulm which probably comprises over 80 per cent. of pure carbonate of lime. Mixed wood costs here $2.25 per cord, and five or six cords are required for a hundred bushels. (See page 144.)

At Mankato, besides the kilns of Maxfield & Sons, Capt. J. R. Beatty has recently erected a fine drawkiln.

At New Ulm are the limekilns of Wm. Winkelmann, Francis Baasen and John Heiman, all burning lime from the Cretaceous. Winkelmann burns about 1800 barrels per year· selling at the kiln, and at New Ulm, for $1.50 per barrel, It here requires 20 cords of mixed wood, at $3.00 per cord, to produce 120 barrels of lime. When freshly burned this lime has very much the same color as the stone, though a little lighter, and slacks white. His kiln stands on the bank of the Minnesota, facing the water, and is built of red quartzite and boulders. Mr. Heiman's kiln holds 150 barrels. Forty cords are needed to burn the kiln well, when filled. Wood costs $2.50 or $3.00 per cord. Lime sells at a dollar or a dollar and fifteen cents per barrel.

Above New Ulm boulders only are used for lime, the kilns being of rude construction. Such are owned by John Edget and Charles Folsom, a short distance below Beaver Falls, and by Andrew Brandin, M. C. Brace, Wm. Davis and brother, —— Brennan, and R. R. Cory, above that place. Large limestone boulders occur about Redwood Falls. At Yellow Medicine the only lime made is derived from large boulders. Peter Casting burns a little lime from such boulders at Jannetteville, nearly opposite the mouth of the Yellow Medicine. At Granite Falls such boulders, occurring in a little ravine on the land of R. H. Baldwin, have been taken for rock *in situ*. At Mr. Hurley's, eight miles above the foot of Big Stone Lake, excellent quicklime is burned from surface boulders, some of which is marketed at Morris, in Stevens county.

Gypsum.

The Cretaceous, at Big Stone Lake, holds large crystals of selenite. They lie on the surface of the weathered slope made by the outcropping of a dark shale, and can be gathered in considerable quantity. They are, of course, embraced within the shale. From the existence of sulphate of lime in quantities that render it of economical importance

in this formation in various parts of the country, it is presumable that this horizon of outcrop is nearly, or exactly the same; and that at some future time, when sufficiently detailed exploration has been made, it may here prove equally valuable. This place has been already described under the head of the Cretaceous.

Fire Clay.

From the Cretaceous, near New Ulm, Mr. Christian Dauffenbach manufactures a good fire brick. The bank from which he takes the clay is fifteen feet above the river. It is of light color, and when wet is plastic, but if dry it is hard and difficult to quarry, the use of powder becoming necessary. Horse power is used for his machinery. He has three kilns. This fire-brick clay lies below a heavy stratum of white sand. If the white sand that occurs on the Maple, a few miles above its union with the Blue Earth, be the same horizon, this fire-clay ought also to be found in the banks of the Blue Earth, a short distance above its mouth. In the settlement and material development of that part of the state, this stratum in the Cretaceous is destined to play an important part. (See page 185.)

Potter's Clay.

The Cretaceous also supplies, near the same place, but from a higher stratum, a good potter's clay, which is largely employed at New Ulm and at Mankato. It is owned by Silas Barnard. Mr. H. B. Kaufer, potter at Mankato, regards it as equal to the Carboniferous potter's clay of Ohio. The manufacturers at New Ulm are Winkelmann and Dauffenbach, and John Stoerker. The pottery sells for twelve and fifteen cents per gallon. (See p. 186.)

Kaolin or China Clay.

It has been said already, in connection with the description of the granites of the valley, that the upper surface of the granites, where protected by the Cretaceous, is overlain by a heavy bed of kaolin clay, resulting from the decomposition of the granite itself. There can be no question but that this deposit, or rather kaolinized granite, since it is decomposed and lies *in situ*, will become of great economical importance. Kaolin is not a common mineral in the drift

latitudes. It is common in New Mexico, where the granite is likewise found to be decomposed to the depth of 50 or more feet. It is also found in the Blue Ridge in Virginia the mountain rock there being changed to impure kaolin to a considerable depth.* Although the purity of the kaolin of the Minnesota valley has not been established by tests either practical or chemical, it is highly probable that some portions of it, at least, will be found to answer all the purposes for which such clay is generally used.

Building Stone.

For construction, the Shakopee limestone holds at present a high position in the regard of builders. Its best estate is not seen at Shakopee but at Ottawa, Kasota and St. Peter. The Mankato quarries are equally as fine. The quarries at Kasota show a deeper shade of pink than those at any of the other foregoing places. The best stone yet furnished by this formation, was that put into the recent enlargement of the Asylum at St. Peter. It was taken out near the Asylum, and lies in very heavy and regular layers. The quarries at Kasota and at Ottawa have not yet penetrated so deeply into the rock, but will prove to be thicker bedded as they are further wrought. The Episcopal church at St. Peter, made of this stone, has dark-brown cornice window frames and blinds, and the wall is painted dark brown, making, although perhaps too somber, yet a very tasty and appropriate edifice for worship. It is low, and of Gothic build.

South from Mankato, on the Blue Earth, the Maple and the Watonwan, are several very favorable openings, but there has not been much working in this stone, nor in any other, in that part of Blue Earth county, the dependence being entirely on the quarries at Mankato. There is no reason, however, why the counties of Martin and Faribault may not derive all their stone for walls and for all building, from these southern quarries, saving themselves the labor of transportation six or ten miles. Stone from these quarries was used in the culverts and bridge piers along the new railroad from Mankato to Wells. At Garden City, the exposure in the bed of the river is owned by J. Willard. This outcrop has more the aspect of the Shakopee limestone, at Shakopee, than any other seen

* Compare *Am. Jour. Sci. and Arts*, III, Vol. VII, p. 74.

and will not be found to furnish as handsome layers as the quarries at Mankato.

At Jordan, the sandstone lying next below the foregoing limestone is somewhat employed for foundations, and has been put into some large buildings. It cuts well, and is in blocks about eight inches thick. It is rather too friable, however, for general use.

The St. Lawrence limestone is a very fine stone for building. It is tough, compact, and of a good color. Its bedding is symmetrical and of convenient thickness. The only quarries known are those at St. Lawrence and at Hebron and Judson. The Presbyterian church at Belle Plaine is built of the St. Lawrence stone, the trimmings being from Ottawa. In the Potsdam at Redstone, quarries are opened by Francis Baasen, Wm. Winkelmann and Frederick Meyerding.

Of the granites and associated rocks there is a great variety. There is also every desired facility for quarrying them. The "gray" and "red" granites afford every kind of shading of color, and a great many beautiful combinations of mineral contents and crystallization. The time cannot be far distant when a great many valuable openings will be made in the granites of the Minnesota valley, for the convenience of the southern part of the State and of Iowa.

Brick.

Common red brick, sometimes also brick of a lighter shade, are manufactured from the alluvium of the river, at New Ulm and Mankato, as well as at other points further down the valley. The Mankato brick have a high reputation, and are extensively shipped to St. Paul. The makers are Meihofer and Whitrock, Reed and Mather, Jager brothers, and Mr. Schlafle. At New Ulm, Wm. Winkelmann owns the only brick yard. At Jordan, Charles Rodel makes a light-colored brick.

Copper.

At Shakopee a stock company exists for sinking a shaft to explore for copper. It is said that in sinking a common well pieces of native copper were found. The shaft is to be as deep as that well which, when vigorously pumped, is said to afford particles of copper with the water. The limestone was struck at 18 feet. The work has not progressed

far enough to indicate the probable result. The limes at Shakopee being of the same age as Calciferous sand of the east, recalls the fact that they both belong t Quebec Group of Canada, which is regarded there as l ing the upper copper-bearing rocks of Lake Superior.

Timber and fuel.

"The Big Woods" of Minnesota, consist of a south prolongation of the timber belt about forty-five miles w in the central part of the State. The boundary of this longation on either side, is not well marked, the trees g ually becoming thinner and smaller, and more and r restricted to the valleys of streams, till the countr changed to a treeless prairie. The surface itself is r rolling than on the east or west. It may be thus descr in general: Beginning a few miles west of Minneapolis eastern edge of the big woods crosses the Minnesota line toward Lakeville, in Dakota county. Continuing southerly direction, it passes about a mile east of Car City, and of Owatonna, when it makes a short bend to west and northwest, passing about six miles north of V eca, and near E. Janesville, in Waseca county. In I Earth county it is variously modified by the valleys that tributary to the Minnesota from the south. Contin west, about six miles south of South Bend, it turns nc and crosses the Minnesota. Running along the west sic the Minnesota, distant from it about four miles, it begir bear off to the northwest at St. Peter, and runs in near direct line to Darwin, on the St. Paul and Pacific R. bending a little to the east, toward Glencoe, in McI county. In passing through these woods from Farming in Dakota county, to Shakopee in Scott county, the lowing species of trees and shrubs were seen. For te twelve miles after entering the woods very few trees seen, the oak shrubs being the largest and almost the tree-like vegetation. About half way to the Minnesota er the maple and large elms, bass and iron wood appear

Oak Shrubs. Apparently Quercus ilicifolia. *Wang.*
Hazelnut. Corylus rostrata. *Ait.* (?)
Bur-Oak. Quercus macrocarpa. *Michx.*
White Oak. Quercus alba. *L.*
Wild Red Cherry. Prunus Pennsylvanica. *L.*
Trembling Aspen. Populus tremuloides. *Michx.*
Sumac. Rhus typhina. *L.*
Choke Cherry. Prunus Virginiana, *L.*

Wild Plum. Prunus Americana. *Marshall.*
White Ash. Fraxinus Americana. *L.*
Sumac. Rhus glabra. *L.*
Thorn. Cratægus.
Rose. Rosa blanda. *Ait.*
Juneberry. Amelanchier Canadensis, Var. Botryapium. *Torr. and Gray.*
Round-leaved Cornel. Cornus circinata. *L'Her.*
Common Elder. Sambucus Canadensis. *L.*
American Crab-Apple. Pyrus coronaria. *L.*
'he young twigs and the under surface of the leaves are very woolly-pubescent.]
Black Cherry. Prunus serotina. *Ehr.*
Frost Grape. Vitis cordifolia. *Michx.*
American Elm. Ulmus Americana. *L.* (*Pl. Clayt.*) *Willd.*
High Bush Cranberry. Viburnum Opulus. *L.*
Two or three species of Willow. Salix.
Green Ash. Fraxinus viridis. *Michx. f.*
Prickly Ash. Zanthoxylum Americanum. *Mill.*
Cockspur Thorn. Crataegus crusgalli. *L.*
Red Raspberry. Rubus strigosus. *Michx.*
Black Currant. Ribes floridum. *L.*
Cottonwood. Populus monilifera. *Ait.*
Large-toothed Aspen. Populus grandidentata. *Michx.*
Bass. Tilia Americana. *L.*
Red Mulberry. Morus rubra. *L.*
Ironwood. Ostrya Virginica. *Willd.*
Sugar Maple. Acer saccharinum. *Wang.*
Soft Maple. Acer rubrum. *L.*
Alternate-leaved Cornel. Cornus alternifolia. *L.*
Bitternut. Carya amara. *Nutt.*
[Rare east of Spring Lake.]
Butternut. Juglans cinerea. *L.*
[Very rare except at Spring Lake and westward.]
Slippery Elm. Ulmus fulva. *Michx.*
Staghorn Sumac. Rhus typhina. *L.*
Tamarac. Larix Americana. *Michx.*
Box Elder. Negundo aceroides. *Moench.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Panicled Cornel. Cornus paniculata. *L'Her.*
[The most common species of *Cornus.*]

In ascending the valley the following additional species ›re seen:

Kentucky Coffee Tree. Gymnocladus Canadensis. *Lam.*
Red Cedar. Juniperus Virginiana. *L.*
Black Walnut. Juglans nigra. *L.*
Hackberry. Celtis occidentalis. *L.*
he hickory grows to about six inches in diameter and then is invariably winter-killed. A tract of many acres is now being cut near St. Peter for fuel, having been killed the past winter. All the trees are small. The hackberry is used for fuel, and for furniture. It is commonest in the heavy timber. The butternut is rarely large. The box-elder sometimes exceeds three feet in diameter.]
Blue Beech. Carpinus Americana. *Michx.*
Yellow or Gray Birch. Betula lutea. *Michx., f.*
here is said to be a species of locust at St. Peter, but it has not been recognized by the survey. The above species of birch has oblong catkins, and spreading lobes on the scales which are 3 inches long. The lobes are obtuse.]

The Trees and Shrubs of Big Stone Lake.

At Mr. Hurley's, eight miles above the foot of Big Ston- Lake, on the north side, the following trees and shrub were seen growing:

Trees—In the order of abundance.

White Ash. Fraxinus Americana. *L.*
Bur Oak. Quercus macrocarpa. *Michx.*
Basswood. Tilia Americana. *L.*
Elm. Ulmus Americana. *L.* (*Pl. Clayt.*) *Willd.*
Box Elder. Negundo aceroides. *Moench.*
[This makes a very fine "maple sugar," and syrup. It is abundant on the islands.]
Cottonwood. Populus monilifera. *Ait.*
Hackberry. Celtis occidentalis. *L.*
Ironwood. Ostrya Virginica. *Willd.*
Soft Maple. Acer rubrum. *L.*
Wild Plum. Prunus Americana. *Marshall.*
Slippery Elm. Ulmus fulva. *Michx.*
Willow. Salix nigra. *Marshall.*

Shrubs.

Grape. Vitis aestivalis. *Michx.* (?)
Gooseberry, (prickly.) Ribes Cynosbati. *L.*
Gooseberry (smooth). Ribes rotundifolium. *Michx.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Black Currant. Ribes floridum. *L.*
Prickly Ash. Zanthoxylum Americanum. *Mill.*
Red Raspberry. Rubus strigosus. *Michx.*
Black Raspberry. Rubus occidentalis. *L.*
Sweet Elder. Sambucus. ?
Sweet Viburnum. Viburnum Lentago. *L.*
Red Osier Dogwood. Cornus stolonifera. *Michx.*
Bittersweet. Celastrus scandens. *L.*
Choke Cherry. Prunus Virginiana. *L.*
Red Rose. Rosa lucida. *Ehr.* (?)
White Rose. Rosa blanda. *Ait.*
Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Waahoo. Euonymus atropurpureus. *Jacq.*
Smooth Sumac. Rhus typhina. *L.*

[The list of plants of Minnesota by Dr. I. A. Lapham, alluded to in the Address to the President, is withheld for future publication.]

ERRATA.

On page 191, 17th line from the bottom, for "supposition" read superposition.
On page 157, 3rd line from the top, for "half a mile," read one mile.

INDEX TO THE GEOLOGICAL REPORT.

PAGE.

Adams, Caleb, turf peat owned by 100
Address to the President 75
Amo, Cottonwood county, peat in 102
Antelope Hills 193
Aiken, Daniel F., quarry of 131
Artesian well, at Sleepy Eye 186
at Wells 198
Aschroft and Betteley's process with peat 107
Aubin's process with peat 116
Asylum quarry, at St. Peter 148
Analyses of peat 92,95
Alkaline deposits, effect on agriculture 194

Barnard, Silas, potter's clay on land of 186,207
Beason, M., quarry of, near St. Lawrence 153
Belle Plaine, limestone exposure near 141
Belle Plaine salt well 79
diagram of 86
conclusions on 85
Beaver Falls, granite at 169
quicklime at 206
hight of the bluffs near 200
Baasen, Francis, lime burned by 206
Big Stone lake, granite at 175
jointing and glaciation at 175
trees and shrubs growing at 212
connected with Lake Travers 199
Bigelow, silt peat at 104
Big Woods, trees and shrubs in 210
the limits of 210
Birch Coolie, granite at 163
kaolin in banks of 163
structure of veins in granite at 163
Blakely, limestone near 141
Bluffs of the Minnesota, description of 196
Blue Earth county, coal in 77
sandstone in 133
building stone in 208,146
Blue Earth river, Shakopee limestone in banks of 145
excavated valley of 145
Building stone 208
Brick 209
Brooklyn, Hennepin Co., peat at 104
analysis of peat from 98
Bush, Geo. C., peat on land of 104
Boulders, in the Minnesota Valley 197

Carboniferous coal in Minnesota 7
Carver, Jonathan, expedition by 12
Cannon City, peat near 10
Castle Rock, views of 13
Comparisons of peat with wood 12
Chatfield, C. E., an assistant on the survey 7
Case, A., drift crag on land of 13
Carver, Jordan sandstone near 14
Cappel's Mill, sandstone near 15
Cobble knolls 13
Cobb river 13
Cottonwood county, peat in 10
surveyed for peat 8
Clapp, Geo. C., quarry of 14
lime kiln of 2
Copper at Shakopee 2
mine of LeSueur 1
Coal, from the Cretaceous 2
in the Minnesota valley 2
from Crow Creek 2
in the Cottonwood valley 18
in the banks of the Redwood 7
in the banks of Little Rock creek 188
Carboniferous, in Minnesota 187
Coteau des Prairies 76
no rocks seen in 194
its hight 194
tufa on, and its origin 195
Contre, Baptiste, kiln of, at Shakopee 195
Cretaceous, exposure at Empire City 205
at Mankato 176
on land of Wm. Fritz 178
at New Ulm 182
on the Lower Silurian 186
on the Waraju 180
at St. Peter 185
near Fort Ridgely 177
near the Lower Sioux Agency 187
at Crow Creek 187
at Redwood Falls 187
near Montevideo 188
at Big Stone Lake 189
general section of, in southwestern Minnesota 190
Crow Creek, granite at 191
coal at 166
187

Dakota county, peat in 99
St. Peter sandstone in 135
Cretaceous in 176
Dauffenbach, Christian, fire-brick manufactured by 207
Des Moines valley, peat in 102
Delafield, Jackson county, peat in 103
Dooleyville, sandstone near 148
Döheny, D., quarry by 155
Drift, composition of, near Mankato 152
and general topography of the Minnesota valley 192
in the Coteau des Prairies 185
at St. Paul 196
Dunn, Wm., peat on land of 102
Dunham, J. H., quarry by 154

Eames, H. H., on Carboniferous coal in Minnesota 76

Economical geology of the Minnesota valley 201
Elsberg's process of working peat 112
Emmons, Dr. E., description of "the Sandstone of Potsdam," by ... 158
Empire City, peat near 100
Cretaceous near 176
St. Peter sandstone near 138
Exomphalus, in the Shakopee limestone 147

Fairmount, peat manufactured near 102
Farmington, quarry near 132
Faribault county, peat in 76, 119, 110
possible Carboniferous coal in 77
Featherstonhaugh's ascent of the Minnesota 129
Fire-clay 207
Flynn, Birney, Cretaceous coal on land of 188
Folsom, S. M., limestone on land of 146
Fort Snelling, composition of bluff 128
Float coal, its origin 76
French, Mr. —, peat on the land of 101
Frankhouse, F., granite near residence of 175
Fritz, Wm., section of Cretaceous sandstone, on land of 182
Freeborn county, possible coal in 77
Furber, P. P., an assistant on the survey 78

Garden City, Shakopee limestone at 146
sandstone at 150
Geology of the Minnesota valley 127
Goodwin John, quarry by 154
Granites of the Minnesota valley 160
at New Ulm 161
near the Lower Sioux Agency 162
at Birch Coolie 163
at the mouth of the Redwood 167
at Beaver Falls 169
at Vicksburg 169
at Minnesota Falls 170
at Montevideo 171
in the ancient Minnesota valley 173
at Lac-qui-Parle 173
at Frankhouse's 175
at Movius 175
at Big Stone Lake 175
at Sauk Rapids and St. Cloud 176
at Crow Creek 166
Glacier marks, direction of 159,175
Gruebel, John, section of Cretaceous on land of 182
Gray, ——, peat on land of 99
Gravel knolls, isolated, their occurrence and cause 196
Gypsum, in the Cretaceous 190,202

Haight, process of working peat 119
peat on the land of 102
Heiman, John, lime made by 206
Hodge's process of working peat 118
Hall, A. J., peat on the land of 103
Haggard, John, turf peat on the land of 105
Hennepin county, peat in 104
Herrick, Captain H. H., tufa burned for lime by 195
Hewitt, Mr., quarry of 153
Hebron, St. Lawrence limestone at 154
Hickory, winter-killed in the Minnesota valley 211

Houghton, George, coal on land of..... 188
Hornblendic schist..... 178
Hurley's lime kiln, at Big Stone lake..... 206
Hurricane Bend, Shakopee limestone at..... 144

Imus, Miss Ellen, peat on the land of..... 102
Iron ore.....133, 202

Jackson county, surveyed for peat..... 88
peat in..... 103
Jessenland, limestone at..... 155
Jordan sandstone, its age..... 140
at Jordan described..... 149
regarded as Potsdam by Dr. Shumard..... 147
at Ottawa..... 149
at Minneopa Falls..... 150
at Red Jacket Mills..... 150
Johnson, Arthur, turf peat on the land of..... 104
Judson, St. Lawrence limestone visible at.....139, 152

Kasota, Le Sueur county, peat marsh in..... 101
Shakopee limestone at..... 139
Kaolin, at Birch Coolie..... 163
at Redwood Falls..... 167
at Minnesota Falls..... 170
its origin..... 207
Keating's geological observations..... 127
King, W. V., peat owned by..... 105
King, E. O., Cretaceous coal on the land of..... 185
Knight, Albert, quarry of, in Shakopee limestone..... 144

Lac-qui-Parle lake, granite at..... 173
La Framboise Place, granite at..... 161
Langdon, B. S., peat on the land of..... 104
Le Sueur county, peat in..... 101
Le Sueur river, Shakopee limestone on..... 139
Leavitt, T. H., on peat at Lake Superior..... 122
Leavitt's process of working peat..... 113
Little Rock Creek, Cretaceous in the banks of..... 187
Loniacheck's quarry, at Jordan..... 149
Long, Major S. H., expedition of, in 1823..... 127
Lone Rock, in Dakota county..... 135
in Rock county..... 160
Louisville, section of rocks at..... 140
Lower Sioux Agency, Cretaceous at..... 187
Lura Station, peat deposits near..... 102
Lime, at Mankato..... 204
at Shakopee..... 205
at New Ulm..... 206
from boulders..... 206
Lincoln, Isaac, lime kiln of..... 205

Mankato, section of rocks at..... 145
observations on the Cretaceous rocks at..... 179
lime kilns at..... 206
Marshner's carding factory, granite at..... 162
Maple river, Shakopee limestone on..... 139
Minnesota Valley, the geology of..... 127
Trenton limestone in..... 131
the economical geology of..... 201
Minnesota Falls, granite at..... 170
kaolin at..... 170

Mineral Paint..... 168, 203
Minneopa Falls, Jordan sandstone at..... 150
Mountain Lake Station, peat near..... 102
Mower county, possible coal in..... 77
Moss peat..... 89
Moyer, S. R., granite reported by..... 173
Movius, granite near residence of..... 175
Montevideo, terrace near..... 189
granite near..... 171
Murphy, James, peat on the land of..... 100

New Ulm, Potsdam sandstone near..... 156
conglomerate near..... 158
granite near..... 161
Cretaceous rocks at..... 186
character of lime at..... 204
Nobles county, surveyed for peat..... 88
peat in..... 104
Norton, E. T., drift-crag on land of, at Garden City..... 134

Ochre, in the Cretaceous..... 190
Ottawa, sections of rocks at..... 131
Jordan sandstone at..... 143

Paint rock, description of, at Redwood Falls..... 168
Peat deposits, survey of, ordered..... 75
objects of the survey of..... 88
Peat, varieties of..... 89
slough..... 89
side-hill..... 90
turi..... 90
quality of peats, in Minnesota..... 91
the working of..... 106
what has been done in..... 125
where it exists in Minnesota..... 99
raw or manufactured..... 125
practical conclusions on..... 126
analyses by Dr. P. B. Rose..... 92
by Prof. S. F. Peckham..... 95
method of testing for..... 99
Peckham, Prof. S. F., report of chemical analyses by..... 95
Post, Wm. H., granite near,..... 162
Potter's clay..... 186, 207
Phillips, Wm., quarry by..... 154
Potsdam sandstone..... 156
at Sioux Falls..... 160

Quartzite, dip of at Redstone..... 158
on the land of the St. Paul and Sioux City R. R..... 159
in the valley of Rock river..... 160
Quinby, H. F., peat on the land of..... 102
Quincy, Olmsted county. Shakopee limestone at..... 140

Rae process of working peat..... 114
Rapidan Mills, Jordan sandstone at..... 150
Red Jacket Mills, Shakopee limestone at..... 146
Jordan sandstone at..... 150
Redstone, dip of the quartzite at..... 158
Redwood valley, coal in,..... 76, 188
granite and kaolin in..... 167
Rice county, peat in..... 102

Rinshed, John P., quarry of..... 141
Robert's Process of working peat..... 10[illegible]
Robinson, J., peat on land of..... 10[illegible]
Rochussen, I. J., location of quartzite by..... 1[illegible]
Rock river, quartzite in the valley of..... 1[illegible]
Rose, Dr. P. B., analyses of peat by..... 92

Salt Springs at Belle Plaine, geological relations of..... 86
Salt Well at Belle Plaine..... 79
Salt Spring Lands, transferred to the Board of Regents..... 75
amount of..... 77
Savage, Rev. E., peat on the land of..... 103
Section of the Fort Snelling bluff..... 128
in the Trenton near Farmington..... 132
in Rapidan..... 133
at Shakopee, in Scott county..... 140
at Louisville..... 140
at Ottawa..... 141
at Mankato..... 145
in Jordan sandstone..... 1[illegible], 152
at Jordan..... 149
at St. Lawrence..... 158
in the Cretaceous at Fritz's quarry..... 182
at John Gruebel's..... 183
at Winkelmann's..... 184
on the Warsju..... 185
general section at New Ulm..... 186
well drilled at Sleepy Eye..... 186
general section of the Cretaceous in southwestern Minnesota 191
of the drift at St. Paul..... 196
Schmidt, peat on the land of..... 105
Sioux Falls, quartzite at..... 160
Silurian rocks, conclusions respecting, at Mankato..... 179
Shumard, Dr. B. F., survey by..... 180
Shell marl, below peat..... 92
Shale, isolated deposits of, in sandstone..... 13[illegible], 150
Shale oil, cost of..... 126
Shakopee, limestone at..... 138
copper at..... 209
Shakopee limestone, at Shakopee..... 138
in Rapidan..... 139
at Louisville..... 140
at Ottawa..... 141
at Mankato..... 145
on the Blue Earth..... 145
on the Maple..... 146
at Garden City..... 146
St. Croix Sandstone..... 155
St. Cloud, peat near..... 105
peat from, analyzed..... 98
St. Peter, limestone at..... 145
peat near..... 101
Cretaceous near..... 177
St. Peter sandstone..... 182
near Empire City..... 188
views of, in Dakota county..... 186
in Rapidan..... 182
St. Lawrence limestone..... 13[illegible], 152
at Judson..... 153
St. Paul, section in drift at..... 196
peat near..... 105

Slough peat 89
Sphagnum palustre 90
Smith, Conrad, kiln of 205
Sleepy Eye, artesian well at 186
Soule, A. A., peat on the land of 102
Synclical in Shakopee limestone 147

Taggart, S. O., peat on land of 102
Talcott lake, peat near 104
Taylor, F. G., peat on land of 104
Thompson, Clark W., peat on land of 101
Terraces in the Minnesota valley 197, 200
at New Ulm 186
six miles below Montevideo 189
Timber and fuel 210
Trap dikes at Granite Falls 171
Trenton limestone and shales 131
Trees and shrubs in the Big Woods 210
at Big Stone Lake 212
Turf 91

Value of peat for fuel 128
Van Oser's creek, sandstone in 148
Valley Springs, quartzite near 160
Vermilion valley, peat in 99
terraces in 176
Vicksburg, granite near 169
Volk, John, quarry by 149

Waraju river, limestone near the mouth of 183
potter's clay in banks of 186, 207
marl on 184
Watonwan river, Shokopee limestone on 146
Ward, A. L., peat manufactured by 102
Whittier, Albert, peat on the land of 99
Williams, Dr. C. D., on transportation of shale oil 125
Winchell, A., on the Belle Plaine salt well 80
Winchell, N. H., on the Belle Plaine salt well 82
Windom, peat near 102
Winkelmann's lime kiln and quarry 184
lime made by 206
Wells, peat near 101
manufacture of peat near 120
artesian wells at 193

ANNUAL REPORT

OF

THE BOARD OF REGENTS

OF THE

NIVERSITY OF MINNESOTA

TO THE GOVERNOR,

FOR THE

FISCAL YEAR ENDING NOVEMBER 30, 1874.

TRANSMITTED TO THE LEGISLATURE AT THE SEVENTEENTH ANNUAL SESSION, 1875.

SAINT PAUL:
ST. PAUL PRESS COMPANY.
1875.

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SAINT PAUL:
PRESS COMPANY.

To His Excellency, Hon. C. K. Davis,
Governor of Minnesota:

SIR:—I have the honor herewith to transmit the Annual Report of the Board of Regents of the University of Minnesota, for the fiscal year ending Dec. 1st, 1874.

With high esteem, I am

Your obedient servant,

J. S. PILLSBURY,

President of the Board of Regents.

BOARD OF REGENTS.

J. S. PILLSBURY, Minneapolis.
H. H. SIBLEY, St. Paul.
W. R. MARSHALL, St. Paul.
PARIS GIBSON, Minneapolis.
CHAS. S. BRYANT, St. Peter.
A. A. HARWOOD, Austin.
MORRIS LAMPREY, St. Paul.

And *Ex-officiis.*

C. K. DAVIS, Governor.
H. B. WILSON, Supt. of Public Inst.
WILLIAM W. FOLWELL, Prest. of University.

ERECTION OF BUILDINGS.

The principal matter of interest relating to the condition of the University during the past year, has been the continuation of work on the new buildings. These buildings, as stated in our last report, consist of an Agricultural College 54 feet square, together with a laboratory and plant house which form two wings, each 25x46 feet; and also of the main part of the academic building of the University, 75x90 feet. Although it was expressly stipulated with the contractors, that they should have these buildings ready for occupancy by the first of August, 1874, they have signally failed to complete either structure within the time contracted. Their repeated promises to have at least one building in readiness by a specified day have been broken from time to time, and at this date, neither structure is completed. The Regents found it necessary to make some changes from the original plans, as for instance, putting up partition walls of brick, in place of wood. Still none of these deviations was sufficient ground for the delay. The non-completion of the buildings is chargeable simply to the laxity and mismanagement of the builders. The season is now so far advanced that there is little prospect of finishing the work before July or August of the coming year.

The occurrence of so much delay has, of course, interfered with the internal development of the institution, causing the failure of accommodations for the library and geological museum, and completely debarring the professors and students from the use of the laboratory for experiments in chem-

istry and agriculture. The Board of Regents are convinced, however, that the buildings now being constructed, will, when finished, afford accommodations which will compare favorably with those to be found in the Universities of our sister States.

REPAIRS AND ALTERATIONS.

The erection of a new building in connection with the original structure (or wing) necessitated some repairs and improvement in the old part, in order to make it correspond externally and internally to the new; accordingly a considerable number of alterations were made. Stairs have been changed, partitions removed, and new recitation rooms formed. The rooms and halls have been wainscoted and kalsomined throughout, and the entire building supplied with heating and ventilating apparatus. Cornices and gables have also been remodeled to harmonize with the more modern architecture of the new building.

These improvements have cost a much larger sum than was expected, and there being no appropriation for this purpose, it has been necessary to pay them from the current expense fund.

APPROPRIATION.

The interest at present accruing to the University from the permanent fund arising from the sales of lands, not being found sufficient to meet the current expenses, the Regents in their last annual report urged upon the Legislature the importance of appropriating a sum adequate to that purpose. We are gratified to report that the Legislature granted this request, making an annual appropriation of $19,000 to cover current expenses. With this generous aid the Board are enabled to carry forward the internal work of the institution without embarrassment.

THE LIBRARY.

An important addition to the library of the University has recently been made. The private collection of Dr. H. P. Tappan, recently President of Michigan University, has finally been secured and put upon the shelves. The Board find this library more than equal to their expectations; it embraces many of the best English editions, together with a number of rare works and costly engravings. The Regents congratulate themselves on their success in securing this valuable collection, and would express their gratitude for the services of Prof. Campbell, who being a friend of Dr. Tappan, assisted in purchasing the library on very favora terms. A considerable number of works recommended by the faculty have also been bought during the year. The library of the University now contains about 10,000 well selected volumes, besides a large collection of pamphlets.

GEOLOGICAL SURVEY.

The Geological Survey of the State has been continued by the State Geologist. Two counties, Mower and Freeborn, in the southern part of the State, have been carefully examined, in order to ascertain whether the formation containing the Iowa coal extends into our own State. No traces of coal were discovered. It is to be regretted that some parties, without the advice of Prof. Winchell, have caused needless expense by independent surveys in this part of the State, which would have been avoided if the proper information had been secured. Upon invitation of Col. Wm. Ludlow, of the Engineers, U. S. A., the months of July and August were occupied in an expedition to the Black Hills in company with Gen. Custer. In addition to valuable scientific information, (for which see report of State geologist,) Prof. Winchell succeeded in collecting a large quantity of geological specimens, together with skins of animals which will be deposited in the museum. The entire expense of the expedition was by the General Government. The in-

complete condition of the laboratory has prevented the University from rendering such aid as should have been given in assaying metals for the mining interests in the northern part of the State. Professor Winchell recommends that some further provision be made to meet the demand for information obtained by the survey, and suggests that a larger number of copies of his report be printed for that purpose. We heartily approve of the suggestion that the results of the geological survey may be more generally made known.

THE FACULTY.

During the year the following changes have taken place:

At the close of the first term, (1873–4,) Rev. W. C. Sawyer closed his connection.

Mr. W. P. Melcher was employed as an instructor in German during the last half of the second term.

Mr. John G. Moore was employed as an instructor in German during the third term, and at the July meeting was elected Assistant Professor to have charge of the same department.

Professor G. Campbell was relieved of the charge of the department of German, to date from the close of the year 1872–3.

The following officers, not having been re-elected at the annual elections held in April, closed their connection with the institution at the end of the year (1873–4:)

Professor A. B. Donaldson, M. A.
Assistant Professor D. P. Strange, B. S.

By authority of the Board, the Executive Committee employed the following instructors for the new year, beginning Sept. 15, 1874:

Professor Moses Marston, M. A., late Professor in t

St. Lawrence University, New York; and Mr. R. W. Laing, LL. D., late in charge of a school at Portland, Oregon; both in the department of English, including History, Rhetoric, Elocution, &c.

Charles Y. Lacy, B. Agr., (Cornell,) to take charge of the Professorship of Agriculture:

The General Faculty is constituted at this date as follows:

WILLIAM W. FOLWELL, M. A., PRESIDENT,
and Teacher of Political Economy.

GABRIEL CAMPBELL, M. A., VICE-PRESIDENT.
Professor of Mental and Moral Philosophy.

VERSAL J. WALKER, M. A.,
Professor of the Latin Language and Literature.

JABEZ BROOKS, M. A.,
Professor of the Greek Language and Literature.

EDWIN J. THOMPSON, M. A.,
Professor of Mathematics and Astronomy.

ELI L. HUGGINS, U. S. A.,
Professor of Military Science.

NEWTON H. WINCHELL, M. A.,
Professor of Geology and Mineralogy.

HELEN SUTHERLAND, M. A.,
Preceptress and Assistant Professor of Latin.

MITCHELL D. RHAME, B. A.,
Assistant Professor of Civil Engineering, &c., in charge.

STEPHEN F. PECKHAM, B. S.,
Instructor in Chemistry and Physics, in charge.

MOSES MARSTON, M. A.,
Instructor in English and Rhetoric, in charge.

RICHARD W. LAING, LL. D.,
Instructor in English, Elocution, &c.

CHARLES Y. LACY, B. Agr.,
Instructor in Agriculture, in charge.

WILLIAM T. SCOTT,
Superintendent of the Experimental Farm.

CHARLES N. HEWITT, M. D.,
Secretary of the State Board of Health; ex-officio, n resident Professor of Public Health.

NUMBER OF STUDENTS.

The entire enrollment of students for the academical y ending June 18, 1873, is as follows:

Senior Class,	3
Junior Class,	14
First Class (Sophomore)	21
Second Class, (Freshman)	37
Third Class,	50
Fourth Class,	133
Special Students,	29
Total,	287

For details see report of the President of the Univers annexed.

THE EXPERIMENTAL FARM.

The past year the experimental farm has been under charge of Mr. W. T. Scott. Considerable additional land

been improved. He has set out about six thousand forest trees for the purpose of ascertaining the species that are best adapted to our soil and climate, and has also been able to conduct some valuable experiments with different varieties of wheat, oats, corn, potatoes, tomatoes and other vegetables. He has further experimented on the use of gypsum, manure, swamp muck, salt, ashes, and other fertilizers; also in mulching and pruning and in the growth of hedges and plant cuttings. He has prepared a detailed statement of the results of 38 of these experiments which is found in the accompanying report of the Professor of Agriculture.

Students who are desirous of making these experiments for themselves, will be assisted every way possible.

APPROPRIATION FOR HEATING AND FURNISHING.

The Legislature, during the last session, made an appropriation of $29,350 to be applied in heating, furnishing and ventilating the University buildings. In conformity with law, the Board advertised for proposals to supply necessary apparatus for heating and ventilation. Four bids were received. That of Messrs. Ide & Spink, of Springfield, Ill., being the lowest, was accepted. Accordingly a contract was closed with these gentlemen to put Ide's steam heating apparatus into the academic buildings for the sum of $13,000, they guaranteeing under ample bonds that the same should give entire satisfaction. The Board has also purchased a considerable amount of furniture for the chemical laboratory and of instruments for the engineering department.

RE-LOCATION OF UNIVERSITY LANDS.

Owing to the most culpable inefficiency of the person appointed by the Governor (in 1872) to locate the University lands embraced in the second congressional grant, about 10,000 acres of the pine lands have proved to be almost destitute of timber. As soon as this fact was ascertained by the Board of Regents, Governor Davis at once requested the

authorities at Washington to suspend the selections made, order that the Board might be permitted to locate other lan in their stead. The impossibility, however, of obtaini valuable pine lands at this late day will make it necessa for the Governor to select lands which are worth much le per acre, and at a loss in the aggregate of a large sum to t University.

FINANCIAL STATEMENT.

PERMANENT FUND.

Amount of permanent fund as per last annual report, - -	$160,181 00	
Amount received for lands sold during year 1874, -	22,918 00	
Amount received for stumpage sold - - - -	6,613 00	
Amount received from State Institution fund, - -	12,000 00	
Total amount at interest Dec. 1st, 1874,		$201,712

EXPERIMENTAL FARM FUND.

Amount on hand as per last annual report,	$671

UNIVERSITY LAND FUND.

Amount on hand as per last annual report,	$359

RECEIPTS AND DISBURSEMENTS FOR CURRENT EXPENSES FROM DEC. 22D, 1873, TO DEC. 1ST, 1874.

Receipts.

Amount on hand as per last annual report, - -	$2,556 00	
Amount received from State Treasurer as per Treasurer's report, - - -	30,000 00	
Amount received for incidentals,	620 00	
Deficit, - - -	8,654 64	
		$41,830 64

Disbursements.

Paid for salaries of faculty, -	$22,326 50	
Paid for repairs, - -	4,479 39	
Paid for advertising, -	246 15	
Paid for library and reading room,	1,735 53	
Paid for chemical laboratory, -	103 54	
Paid for fuel, - -	1,494 10	
Paid for incidentals, -	2,445 43	
For payment of warrants drawn on State Auditor, -	9,000 00	
		$41,830 64

GEOLOGICAL SURVEY.

Receipts.

From State Treasurer as State aid,	$2,000 00	
Deficit, - - -	2,129 53	
		$4,129 53

Disbursements.

Deficit as per last annual report,	$559 93	
Paid for salary of State Geologist,	2,400 00	
Paid for incidental expenses, -	1,169 60	
		$4,1

HEATING AND FURNISHING ACCOUNT.

Receipts.

Received from State Treasurer as per Treasurer's report, - - - - - -	$26,5

Disbursements.

Paid Ide & Spink on contract, -	$10,000 00	
Paid for apparatus and furniture,	4,419 59	
Balance on hand, -	12,080 41	
		$26,5

BUILDING ACCOUNT.

Receipts.

Received from State Treasurer as per Treasurer's report, - - - - - -	$50,(

Disbursements.

Paid M. O'Brien on contract, -	$44,378 63	
Paid Alden & Long, architects,	714 00	
Paid E. P. Bassford, architect, -	325 00	
Paid H. Weeks, superintending work, - - -	876 00	
Paid L. W. Leeds, Ventilating Engineer, - - -	50 00	
Paid for advertising, -	22 65	
Paid for incidentals, - - -	81 28	
Balance on hand, -	3,552 44	
		$50,

The report of Hon. Paris Gibson, Treasurer, is herewith appended.

OUR PRESENT WANTS.

It was the expectation of the Board of Regents, that the sum of fifty thousand dollars appropriated by the Legislature for University buildings would be sufficient to complete all the buildings at present demanded by the institution. Estimates were accordingly made by competent architects for two buildings, a main academic building and an agricultural college building on that basis. The plans first submitted were cut down in order to remove all doubt that the allotted sum would finish the two structures. The amount needed, however, to complete the same, and to make the unavoidable changes required in finishing them is found to exceed the estimates, and it becomes necessary in order that these buildings now in process of erection be fully completed, to call upon the legislature for a further appropriation. It is necessary also to provide adequate sewerage and reservoirs and to make provisions for fencing and grading the University grounds. To secure these ends an appropriation of $10,000 to finish buildings, and of $15,000 for sewerage, &c., will be required. With these sums the University will be thoroughly equipped. The Board feel assured that the money paid thus far has been well expended, that the work has been done thoroughly and done reasonably, and that the buildings of the University of Minnesota will be a source of just pride to the State.

TREASURER'S REPORT

PARIS GIBSON, TREASURER, IN ACCOUNT WITH BOARD OF REGENTS OF STATE UNIVERSITY.

CURRENT EXPENSE.

1873.		Dr.	
Dec. 17,	To balance		$2,556 00
1874.			
Jan. 7,	To cash from State Treasurer		2,000 00
Mar. 13,	To cash from State Treasurer		3,000 00
28,	To cash from State Treasurer		3,000 00
May 6,	To cash from State Treasurer		3,000 00
June 2,	To cash from State Treasurer		3,000 00
30,	To cash from State Treasurer		3,000 00
Oct. 16,	To cash from State Treasurer		3,000 00
30,	To cash from State Treasurer		3,000 00
Nov. 12,	To cash from State Treasurer		4,000 00
15,	To cash from State Treasurer		1,000 00
16,	To cash from State Treasurer		2,000 00
Sept. 19,	To cash from incidentals		150 00
23,	To cash from incidentals		200 00
23,	To cash from incidentals		200 00
24,	To cash from incidentals		50 00

		Cr.	
Jan. 7,	By cash borrowed on order, 1873		$2,00[illegible]
Oct. 30,	By cash borrowed on order, 1873		3,00[illegible]
Nov. 12,	By cash borrowed on order, 1873		4,00[illegible]
1873.			
Dec. 24,	By cash, incidentals, Folwell	voucher 1..	[illegible]
1874.			
Jan. 6,	By cash, Janitor	voucher 3..	[illegible]
4,	By cash, fuel	" 4..	[illegible]
6,	By cash, fuel	" 5..	[illegible]
10,	By cash, library and reading room	" 7..	[illegible]
10,	By cash, library, St. Paul Press	" 8..	[illegible]
10,	By cash, chemical laboratory	" 9..	
10,	By cash, fuel	" 11..	[illegible]
1,	By cash, salaries, faculty, for Dec	" 12..	2,0[illegible]
10,	By cash, salary, Treasurer, Jan., 1874	" 13..	[illegible]
10,	By cash, salary, Secretary, Dec. 9, 1873	" 14..	[illegible]
20,	By cash, fuel	" 16..	[illegible]

Feb.	3,	By cash, Janitor	Voucher	17..
	1,	By cash, salaries, faculty, Jan	"	20..
	19,	By cash, cover for record	"	21..
	20,	By cash, advertising, St. Paul Press	"	22..
	23,	By cash, advertising, St. Paul Pioneer	"	23..
	19,	By cash, wood sawyer	"	24..
	28,	By cash, salaries, faculty, Feb	"	26..
	28,	By cash, salary, Melcher	"	27..
Mar.	4,	By cash, chemical laboratory	"	28..
	5,	By cash, Janitor	"	29..
	9,	By cash, advertising, Farmers' Union	"	30..
	25,	By cash, Janitor	"	32..
	25,	By cash, chemical laboratory	"	34..
	25,	By cash, fuel	"	35..
	25,	By cash, fuel	"	37..
	25,	By cash, incidentals	"	39..
	25,	By cash, Dr. Welch	"	40..
	30,	By cash, salary, Strange	"	41..
	30,	By cash, fuel, Paulson	"	42..
	30,	By cash, advertising, Barnard	"	44..
	30,	By cash, library	"	45..
	30,	By cash, library	"	46..
	30,	By cash, library	"	47..
	30,	By cash, library	"	48..
	30,	By cash, library, Clarke	"	49..
	30,	By cash, library, Clarke	"	50..
	30,	By cash, library, Hutchinson	"	51..
	30,	By cash, library, Smith	"	52..
	31,	By cash, fuel, Demeules	"	54..
	31,	By cash, fuel, Berthiume	"	55..
	31,	By cash, salaries, faculty, March	"	57..
April	30,	By cash, advertising, Farmers' Union	"	59..
	30,	By cash, salaries, faculty, April	"	60..
May	5,	By cash, Janitor	"	62..
	8,	By cash, advertising, Citizen	"	66..
	11,	By cash, Cleveland & French	"	68.
	31,	By cash, salaries, faculty, May	"	78..
June	1,	By cash, fuel	"	74..
	1,	By cash, fuel	"	75..
	1,	By cash, chemical laboratory	"	76..
	1,	By cash, Janitor	"	77..
	17,	By cash, library, Clarke	"	85..
	20,	By cash, Janitor	"	87..
	20,	By cash, salaries, faculty, June	"	90..
	20,	By cash, salary, Hutchinson	"	91..
	18,	By cash, dinner, Band	"	93..
	18,	By cash, transporting Band	"	112..
July	1,	By cash, advertising Farmers Union	"	95..
	8,	By cash, repairs, McAnnulty	"	96..
	16,	By cash, balance incidentals, Folwell	"	165..
Aug.	1,	By cash, freight, E. S. Huggins	"	128..
	5,	By cash, advertising, Farmers' Union	"	133..
July	16,	By cash, library	"	108..
	30,	By cash, salary and house rent	"	109..
	13,	By cash, repairs, Goodale	"	121..
Aug.	1,	By cash, chemical laboratory	"	132..
	6,	By cash, freight, E. S. Huggins	"	134..
	12,	By cash, printing	"	137..
	22,	By cash, repairs, Goodale	"	140..

Aug.	29,	By cash, repairs, Goodale	voucher	145..	144 20
	31,	By cash, freight, E. S. Huggins	"	146..	34 56
Sept.	3,	By cash, library	"	148..	20 80
	10,	By cash, advertising	"	154..	87 50
	13,	By cash, advertising, Farmers' Union	"	155..	8 33
	11,	By cash, library, freight	"	156..	76 72
	11,	By cash, library, freight	"	157..	3 00
	15,	By cash, repairs, Goodale	"	161..	708 42
	18,	By cash, repairs, Farnham & Co.	"	163..	281 44
	1,	By cash, printing	"	167..	42 00
	25,	By cash, Janitor	"	180..	24 00
	21,	By cash, fuel, Young	"	187..	35 00
	24,	By cash, repairs, Morrison Bros	"	188..	184 00
	29,	By cash, fuel	"	189..	17 93
	30,	By cash, repairs, Copeland	"	190..	80 00
Mar.	11,	By cash, surveying	"	192..	5 50
	28,	By cash, vouchers	"	195..	6 25
Aug.	1,	By cash, repairs, Robinson & Co	"	201..	30 58
	4,	By cash, repairs, ventilators	"	202..	260 50
Sept.	30,	By cash, salaries, faculty, Sept	"	221..	1,925 00
	29,	By cash, incidentals	"	207..	12 00
Oct.	1,	By cash, repairs, Cushman	"	211..	7 90
	3,	By cash, repairs, Sheely	"	213..	132 02
	3,	By cash, library	"	215..	120 00
	8,	By cash, printing	"	216..	8 33
	7,	By cash, repairs, Chansen's	"	218..	188 82
	13,	By cash, Janitor	"	222..	36 00
	15,	By cash, salary Clarke	"	223..	1 00
	16,	By cash, inspecting lands, Hazen	"	224..	100 00
	28,	By cash, repairs, Perkins	"	229..	8 65
	31,	By cash, repairs, Farnham & Co.	"	231..	162 40
	31,	By cash, salaries, faculty, Oct.	"	232..	1,933 00
Nov.	4,	By cash, repairs, Lyman	"	234..	5 25
	5,	By cash, fuel	"	240..	32 20
	5,	By cash, pamphlets	"	241..	80 00
	11,	By cash, repairs, Cass	"	242..	11 13
	14,	By cash, repairs, Goodale	"	243..	21 84
Aug.	..,	By cash, incidentals	"	245..	6 80
Nov.	17,	By cash, repairs, Greeley	"	246..	2 39
	19,	By cash, abstracts	"	249..	7 00
	24,	By cash, repairs, Wheaton & R.	"	251..	110 14
	27,	By cash, repairs, Talbot & White	"	254..	11 21
	30,	By cash, salaries, faculty, Nov.	"	256..	1,933 00
	30,	By cash, salary, Secretary.	"	258..	100 00
	30,	By cash, incidentals, Secretary	"	261..	2 00
Sept.	12,	By cash, Benjamin	"	266..	3 55
Nov.	30,	By cash, repairs, Wheaton & R.	"	277..	2 48
Oct.	28,	By cash, library and reading room	"	279..	17 99
Dec.	7,	By cash, repairs, Bowman	"	283..	2 73
	7,	By cash, repairs, Lyons	"	283..	25 52
	7,	By cash, repairs, Bowman	"	284..	8 46
	7,	By cash, repairs, Bowman	"	285..	2 47
	4,	By cash, advertising, Citizen	"	286..	3 50
	7,	By cash, check books.	"	287.	1 20
	9,	By cash, salary, Secretary, Dec. 1874	"	288..	100 00
	9,	By cash, salary, Treasurer, Jan., 1875	"	289..	300 00
	9,	By cash, Hulet, Fireman	"	290..	45 00
	11,	By cash, library and reading room	"	293..	8 00
	10,	By cash, repairs, Plant.	"	294..	1 70
	12,	By cash, advertising, Farmers' Union	"	295..	8 33

c.	13,	By cash, Treasurer's books	voucher	297..	6 00
	16,	By cash, salaries of faculty.....	"	298..	2,025 00
		To cash, repairs, doors sold.....		20 00	
	16,	By cash, library and R. R. Tappen, library..	vouch'r	299..	1,000 00
	15,	By cash, Cass, twine.....	"	300..	22 90
	15,	By cash, Cass, Janitor.....	"	301..	90 00
	16,	By cash, incidentals, Newton.....	"	302..	9 00
	16,	By cash, salary, Goof.....	"	303..	35 00
	17,	By cash, library and r'ding room, Campbell	"	304..	10 00
	17,	By cash, inspecting lands, Hazen.....	"	305..	441 65
		Balance.....		8,654 64	
				$41,830 64	$41,830 64

BUILDING ACCOUNT.

1873.		Dr.	
pt.	16,	To cash	$5,000 00
t.	10,	To cash	5,000 00
	22,	To cash.....	5,000 00
1874.			
pril	2,	To cash.....	3,000 00
	17,	To cash.....	3,000 00
ay	9,	To cash.....	3,000 00
ne	8,	To cash.....	3,000 00
ly	9,	To cash.....	3,000 00
	11,	To cash.....	3,000 00
g.	4,	To cash.....	3,000 00
	12,	To cash.....	3,000 00
pt.	3,	To cash.....	5,000 00
	12,	To cash.....	5,000 00
v.	25,	To cash.....	1,000 00

1873.		Cr.			
pt.	30,	By cash, McMullen.....	voucher	8..	$45 00
t.	16,	By cash, O'Brien.....	"	7..	1,300 00
	17,	By cash, Alden & Long.....	"	8..	714 00
c.	3,	By cash, Advertising, Tribune.....	"	20..	16 25
v.	26,	By cash, O'Brien.....	"	16..	350 00
	10,	By cash, Mills Bros.....	"	13..	10 00
1874.					
n.	8,	By cash, Bassford, Ag. Building.....	"	15..	260 00
ar,	14,	By cash, O'Brien.....	"	31..	500 00
	30,	By cash, O'Brien.....	"	43..	1,000 00
	30,	By cash, O'Brien.....	"	53..	700 00
pril	8,	By cash, O'Brien.....	"	56..	500 00
ay	6,	By cash, O'Brien.....	"	61..	3,001 44
ne	2,	By cash, O'Brien.....	"	79..	2,923 00
	16,	By cash, O'Brien.....	"	88..	2,200 00
	12,	By cash, Leeds.....	"	92..	50 00
ly	8,	By cash, O'Brien.....	"	97..	1,456 25
	2,	By cash, O'Brien.....	"	98..	2,865 00
	30,	By cash, Expense to Chicago, Folwell.....	"	107..	73 35
	20,	By cash, O'Brien.....	"	123..	2,000 00
	24,	By cash, Long.....	"	124..	300 00
	31,	By cash, Hazen Weeks.....	"	126..	100 00

Aug.	10,	By cash, O'Brien	Voucher	139..	2,839	13
	28,	By cash, Hazen Weeks	"	143..	160	00
	29,	By cash, O'Brien	"	144..	150	00
Sept.	2,	By cash, O'Brien	"	147..	5,300	00
	12,	By cash, O'Brien	"	158..	864	83
	15,	By cash, O'Brien	"	159..	505	60
	15,	By cash, O'Brien	"	160..	136	16
	5,	By cash, O'Brien	"	164..	600	00
	21,	By cash, O'Brien	"	177..	1,735	17
	9,	By cash, Pillsbury	"	185..	72	42
	15,	By cash Stetson	"	186..	3	50
Oct.	1,	By cash, St. Paul Pioneer	"	212..	5	40
	6,	By cash, O'Brien	"	217..	4,500	00
	17,	By cash, O'Brien	"	226..	1,500	00
Nov.	3,	By cash, O'Brien	"	233..	3,000	00
Oct.	4,	By cash, Hazen Weeks	"	239..	200	00
Nov.	16,	By cash, O'Brien	"	247..	62	05
	28,	By cash, O'Brien	"	253..	4,000	00
	27,	By cash, Bassford	"	255..	6	00
April	1,	By cash, Incidentals	"	196..	1	75
Dec.	9,	By cash, Building material	"	291..	170	25
	12,	By cash, Hazen Weeks	"	296..	21	00
					$50,000 00	$46,441 56
		Balance				3,558 44
					$50,000 00	$50,000 00

GEOLOGICAL SURVEY, ACCOUNT.

1874.					
Aug.	13,	To cash		$2,000 00	
1873.					
Dec.	8,	By balance			$559 98
	26,	By cash, Prof. Winchell,	voucher 2		100 00
1874.					
Jan.	1,	By Prof. Winchell in	" 12..		200 00
	7,	By cash, Hardware	" 6..		180 80
	7,	By cash, Prof. Winchell	" 10..		50 60
Feb.	1,	By cash, Prof. Winchell in	" 20..		200 00
	11,	By cash, St. Paul Press	" 18..		17 50
	16,	By cash, Prof. Winchell	" 19..		100 00
	28,	By cash, Chemical Laboratory	" 191..		30 50
	28,	By cash, Prof. Winchell in	" 26..		200 00
Mar.	25,	By cash, Chemical Laboratory	" 83..		7 86
	25,	By cash, Harness, &c	" 36..		36 25
	31,	By cash, Prof. Winchell, in	" 57..		200 00
April	6,	By cash, Chemical Laboratory	" 58..		21 50
	30,	By cash, Prof. Winchell, in	" 60 :		200 00
May	31,	By cash, Prof. Winchell, in	" 78..		200 00
June	20,	By cash, Prof. Winchell	" 86..		100 00
	30,	By cash, Prof. Winchell, in	" 90..		200 00
Aug.	1,	By cash, Prof. Winchell	" 127..		200 00
	12,	By cash, Tribune Peat Report	" 136..		65 26

Sept.	3,	By cash, Prof. Winchell	Voucher	152..
	28,	By cash, Prof. Winchell	"	183..
	28,	By cash, Ramaley & Cunningham	"	206..
	29,	By cash, Expenses on survey	"	208..
Oct.	31.	By cash, Pro. Winchell, in.	"	232..
Nov.	30,	By cash, Expenses on survey	"	281..
	30,	By cash, Prof. Winchell, in	"	256..
Dec.	10,	By cash, Moore	"	292..
	16,	By cash, Prof. Winchell, in	"	298..

Balance

HEATING AND FURNISHING.

1874. DR.

Aug.	28,	To cash
Sept.	21,	To cash
Oct.	6,	To cash
	6,	To cash
	20,	To cash
Nov.	25,	To cash
	30,	To cash

CR.

June	8,	By cash, Westborough & Co	voucher	83..
	16,	By cash, express.	"	89..
	29,	By cash, P. Sprague & Co	"	94..
	23,	By cash, Ritchie & Sons	"	166..
July	1,	By cash, freight	"	105..
	17,	By cash, Sniks	"	110..
	30,	By cash, freight	"	125..
Aug.	7,	By cash, Peckham's expenses to Red Wing	"	130..
	7,	By cash, freight	"	131..
	10,	By cash, Tribune Co	"	138 .
Feb.	24,	By cash, instruments	"	25..
Aug.	21,	By cash, freight	"	141..
	27,	By cash, steam heating, Ide & Spink	"	142..
	29,	By cash, machinery	"	158..
Sept.	2,	By cash, freight	"	168..
	12,	By cash, work	"	169..
	12,	By cash, Bowman	"	170..
	12,	By cash, hardware	"	171..
	12,	By cash, glass	"	172..
	14,	By cash, sash and mouldings	"	173..
	19,	By cash, labor, Presley	"	174..
Aug.	19,	By cash, labor, Peck	"	175..
	19,	By cash, steam heating, Ide & Spink	"	176..
	24,	By cash, dressed lumber	"	178..
	26,	By cash, labor, Peasley	"	181..
	26,	By cash, labor, Peck	"	182..
	28,	By cash, lumber	"	184..

May	30,	By cash, hardwood lumber	voucher	198..		
July	8,	By cash, lumber	"	200..		
Oct.	3,	By cash, Sheely	"	214..		1
	10,	By cash, Benjamin, apparatus	"	219..		1,(
	10,	By cash, Benjamin, sulph. acid	"	220..		
	9,	By cash, dressing oak	"	225..		
	28,	By cash, hydraulic ram	"	227..		1
	28,	By cash, steam heating, Ide & Spink	"	228..		2,(
Nov.	14,	By cash, labor on cisterns	"	237..		1
	14,	By cash, hydraulic ram, Weeks	"	238..		1
	14,	By cash, steam heating, Ide & Spink	"	244..		2,(
	10,	By cash, hydraulic ram	"	246..		1
	19,	By cash, advertising, St. Paul Press	"	250..		
	25,	By cash, Geo. Wale & Co.	"	252..		1
April	21,	By cash, silver dish and crucible	"	257..		
Oct.	6,	By cash, box of levels.	"	262..		
	6,	By cash, hardware	"	263..		
Nov.	10,	By cash, labor, Bowman	"	264..		
Sept.	29,	By cash, freight	"	265..		
Oct.	6,	By cash, hardware	"	267..		
	8,	By cash, freight	"	268..		
	17,	By cash, labor, Peck	"	269..		
Nov.	3,	By cash, freight	"	270..		
	3,	By cash, freight	"	271..		
	12,	By cash, freight	"	272..		
Dec.	15,	To cash.			2,500 00	
Nov.	13,	By cash, paint and painting	voucher	273..		
	30,	By cash, laboratory table	"	274..		
	30,	By cash, lumber	"	275..		
Oct.	29,	By cash, moulding	"	276..		
Nov.	30,	By cash, moulding	"	278..		
Oct.	31,	By cash, apparatus	"	280..		
					$26,500 00	$14,(
		Balance				12,(
					$26,500 00	$26,(

EXPERIMENTAL FARM, ACCOUNT.

1873.		Dr.	
Dec.	1,	To balance	$671 87
1874.			
Mar.	30,	To cash, Field's balance	121 50
April	18,	To cash, hay	66 00
	28,	To cash, hay	50 00
June	1,	To cash, hay	46 55
	30,	To cash, hay	28 20
	30,	To cash, wood	9 00
Aug.	1,	To cash	63 80
Oct.		To cash	9 00
		To cash	18 00
Nov.		To cash, hay.	9 00
		To cash, hay	9 00
		To cash, hay and straw	10 75

CR.

Mar.	25,	By cash, Willes	voucher	38..
May	9,	By cash, Bowman, trees, &c	"	63..
	9,	By cash, labor, Peterson	"	64..
	8,	By cash, freight	"	65..
	8,	By cash, potatoes	"	67..
June	1,	By cash, labor, Wixom	"	69..
	1,	By cash, labor, Peterson	"	70..
	1,	By cash, strychnine	"	71..
	1,	By cash, setting box on wagon-tub	"	72..
	1,	By cash, Scott, farmer	"	73..
	8,	By cash, desk, Gilman & Hazelton	"	80..
	6,	By cash, trees, Moulton	"	81..
	8,	By cash, bran and seeds	"	82..
	8,	By cash, plants, Buckendorf	"	84..
	27,	By cash, fencing	"	100..
	22,	By cash, labor, Whelpey	"	101..
	24,	By cash, ground feed	"	102..
May	20,	By cash, plough, &c	"	99..
July	1,	By cash, Scott, farmer	"	103..
	1,	By cash, labor, Peterson	"	104..
	1,	By cash, labor, Wixom	"	106..
	21,	By cash, labor, Dunning	"	111..
	16,	By cash, labor, Peterson	"	113..
	15,	By cash, labor, Robinson	"	116..
	25,	By cash, labor, Thompson	"	117..
	18,	By cash, labor, Lowerson	"	120..
	20,	By cash, feed	"	122..
	18,	By cash, labor, haying	"	129..
Aug.	1,	By cash, labor, Wixom	"	114..
	1,	By cash, Scott, farmer	"	115..
	1,	By cash, labor, haying	"	118..
	1,	By cash, labor, Lowerson	"	119..
	1,	By cash, labor, Peterson	"	135..
Sept.	1,	By cash, Scott, farmer	"	149..
	1,	By cash, labor, Wixom	"	150..
	1,	By cash, labor, Lowerson	"	151..
	17,	By cash, labor, Thompson	"	162..
	24,	By cash, evergreens, Ford	"	179..
Mar.	25,	By cash, rent	"	193..
	25,	By cash, repairs, pump	"	194..
July	1,	By cash, surveying	"	199..
Sept.	30,	By cash, labor, Lowerson	"	203..
	30,	By cash, threshing	"	204..
July	18,	By cash, Prof. Rhame, surveying	"	205..
Oct.	1,	By cash, Scott, farmer	"	209..
	1,	By cash, labor, Wixom	"	210..
May	25,	By cash, trees, Bowman	"	230..
Nov.	4,	By cash, Scott, farmer	"	235..
	4,	By cash, labor, Moody	"	236..
	30,	By cash, labor, Wixom	"	259..
	30,	By cash, Scott, farmer	"	260..

Balance

1873.	Land Sales Fund—		
	By balance	$359 42	
	Building Account—		
	By balance	3,522 44	
	Heating and Furnishing—		
	By balance	12,080 41	
	Current Expense—		
	To balance		$8,6
	Experimental Farm—		
	To balance		2
	Geological Survey—		
	To balance		2,1
		$15,992 27	$11,0
	To balance on hand		4,9
		$15,992 27	$15,9

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 1st, 1874.

President of the Board of Regents:

› honor herewith to transmit, the
t of the condition and progress of the

ɔnor to be, Sir,
ɜpectfully,
Your obedient servant,
WILLIAM W. FOLWELL,
President.

REPORT OF THE

OF THE UNIVERSITY.

Board of Regents:

e year 1873–74, the period covered by
ith the Commencement on the 18th day

COMMENCEMENT.

re held in the First Congregational
rs of which acknowledgment is due for
).
rees were duly conferred:
achelor of Arts, upon George Edwin
n county; the degree of Bachelor of
ı Chatfield, of Fillmore county.
ere made by the Rev. F. T. Brown,
the Rev. Edward D. Neill, President
e; the Rt. Rev. H. B. Whipple, D. D.,
s Excellency Governor Davis.
these addresses which was written out

WORK OF THE YEAR.

The attention of your honorable body is respectfu called to the accompanying reports of the Professors a Assistant Professors in charge of the departments of i struction. These documents show the work of the sever departments and certain suggestions of importance. T some of them reference will be hereafter made. The a nual report lately made to the State Superintendent of Pul lic Instruction contains a tabulated statement of the who work of the institution for the year. If thought best t you, these tables can be appended to this report. [S appendix B.]

STUDENTS.

The total number of students enrolled during the yea (1873–4) was 278, of whom 206 were gentlemen, and ladies. The number enrolled in the usual college class was 75. On account of the financial panic which set in sor after the opening of the year, the attendance of the seco and third terms was considerably cut down without affecti the yearly enrollment. It should be noted that a stude once admitted and enrolled is entitled to the privileges of t institution, until honorably dismissed or dropped for m conduct or unauthorized absence.

The following tables show the enrollment and classific tion of students for the year (1873-4):

COLLEGE OF SCIENCE, LITERATURE, AND THE ARTS.

Class.	Course.	Gentlemen.	Ladies.	Total
Senior	Classical	1	0	1
	Scientific	1	0	1
Junior	Classical	5	0	5
	Scientific	3	0	3
	Literary	2	1	3
		12	1	13

COLLEGE OF THE MECHANIC ARTS.

Class.	Course.	Gentlemen.	Ladies.	Total.
Senior	Civil Engineering	2	0	2
Junior	Civil Engineering	2	0	2
		4	0	4

COLLEGIATE DEPARTMENT.

Class.	Course.	Gentlemen.	Ladies.	Total.
First	Classical	5	0	5
	Scientific	11	0	11
	Literary	3	2	5
		19	2	21
Second	Classical	18	0	18
	Scientific	10	1	11
	Literary	1	7	8
		29	8	37
Third	Classical	13	0	13
	Scientific	23	5	28
	Literary	6	3	9
		42	8	50
Fourth	Classical	12	1	13
	Scientific	72	26	98
	Literary	7	15	22
		91	42	133
Unclassified		12	17	29
		193	77	270

Summary.

Department.	Class.	Gentlemen.	Ladies.	Total.
College of Science, Literature and Arts	Senior.	2	0	2
	Junior.	11	0	11
College of Mechanic Arts	Senior.	2	0	2
	Junior.	2	0	2
Collegiate Department	First.	19	2	21
	Second.	23	9	37
	Third.	42	8	50
	Fourth.	91	42	133
	Special.	12	17	29
Total Enrollment		209	78	287

COLLEGE OF LAW.

(Not organized.)

COLLEGE OF MEDICINE.

(Not organized.)

RELATIONS TO HIGH SCHOOLS.

As the Board are aware, a resolution has been standing on the record for more than two years, by virtue which the lowest class of the Collegate Department is to be discontinued at the close of the next University year (1874–5.) This resolution was adopted in deference to high professional authority, and to a supposed public sentiment unfavorable to the long continuance of lower elementary work by the University.

I deem it a question worthy of the consideration of the Board, whether the resolution referred to had better be adhered to.

While it is the declared and well understood policy of the University to liberate herself from elementary work so fast as possible, it is none the less well known that the intention of the responsible managers is to maintain an actual articulation with the public school system of the State.

Our theory is to build the University on the foundation of the High Schools. The High Schools, however, as a class have no uniform organization, many of them are as yet unable, however well disposed, to offer courses of studies leading to the University. The few students fitted by them

for college, are commonly sent to Eastern institutions. This, however, is no fault of the schools, but takes place chiefly through the desire of fathers to have their sons educated in the same colleges which they themselves attended.

The result is that the large majority of non-resident students come from the *country districts* with such preparation as the country and village schools can give them. It has been frequently remarked by such students that it costs them no more to attend the Elementary Department of the University, to which they are welcome, than a city high school to which they are not welcome, and which they can only attend on sufferance.

It is obvious that should we prematurely, and too abruptly cut off the lower elementary branches that we should open a chasm between the university and the schools which could not immediately be bridged.

In order that there may be ample time for the further consideration of this grave matter, and if need be, of further action, I respectfully recommend that the resolution to drop the fourth class be so amended as not to take effect until after still another year; that is to say, after the close of the year 1875-6. *

By reference to any of the late circulars it will be seen that the requisites for admission to the Fourth Class of the COLLEGIATE DEPARTMENT are:

Reading, Writing and Spelling;
English Grammar and Analysis;
Arithmetic and Elementary Algebra;
Geography and United States History;
Latin Grammar, *optional.*

The dropping of the Fourth Class will add to this list, as the courses now stand, the following studies:

For all courses: Algebra, English Composition, Physiology and General History; additional for the Classical Course: Cæsar, Cicero, and Greek Grammar and Reader; for the Scientific Course: Physical Geography, Natural Philosophy, Free-hand Drawing, and one year's language either English, Latin or Greek: for the Modern Course, also History of England, Higher English Grammar, and one year's language, Latin or Greek, or one year's Science, as in Scientific Course.

* The Board have so ordered—Resolution of Dec. 29, 1874.

The practical question is: When can these studies be wholly relegated to the schools, without cutting off the great body of the youth of the State from reaching the higher classes of the University?

The Board are already in possession of my personal views on this subject. I desire, therefore, only to reiterate at this time my conviction that two things ought to be done. (1.) The High Schools of the State ought to be enabled to take up and carry on work preparatory to the University, admitting all competent applicants from the adjacent counties or counties, without burdening the local tax payers. (2.) Private academies located in villages too small to support High Schools ought to be encouraged by State aid to prepare students for the University, upon such conditions and under such restrictions as will virtually incorporate such institutions into the system of public instruction. When all agencies are doing all they can, none too much will be done.

COURSES OF STUDY.

Agreeably to your instructions, the General Faculty have undertaken and completed a thorough revision of the courses of study in the four Colleges or Departments now organized. [See appendix C.] The changes made involve no departures from your general plans and policy. Studies have been transferred from term to term, sometimes for theoretical reasons, but more commonly for the purpose of distributing the work of the professors economically. As a general thing the arrangement made gives equal work to each officer, term by term. The range of optional work in the higher Colleges has been somewhat extended, but not without careful regard to the present resources of the institution. Optional studies and courses of study imply a large teaching force. The only department which seems to need further mention in this place is that of Agriculture. According to the general plan of the University, the College of Agriculture proper is based on the preparatory work of the Collegiate Department. The Scientific Course is the proper avenue to the professional studies of the College of Agriculture, leading to a Baccalaureate degree.

The General Faculty, however, have concluded, that it might well be made more apparent than heretofore that the farmer's son, with such schooling as he is likely to have had can be admitted at once to the University and enrolled in

the College of Agriculture. Accordingly in addition to the regular advanced course of study in the Agricultural College, an elementary course in agriculture has been organized. This course is in the main identical with the Scientific Course of the Collegiate Department. For the first six terms the two courses are precisely identical; for the last six, they differ in four studies only, and but two of the four studies can with propriety be called agricultural: the others, Meteorology and Entomology, are branches of general science.

While appreciating the motives which have prompted to the adoption of this Elementary Course in Agriculture, and trusting that it will be found useful and attractive to many farmer's sons, I must be permitted to say that my judgment does not fully approve it. Chiefly, because it is a misnomer. If this is an Agricultural Course what is that other called scientific which differs from it in so very few particulars? I am at all times opposed to accomplishing good ends by indirections. We can not long deceive the public with the show of a course of studies labeled *agricultural* which, when looked upon in detail, proclaims itself to all as merely a general Scientific Course of studies, with here and there a touch of agricultural color.

At this point I would respectfully request permission to insert the brief paper, which was presented to and read before your honorable body some months ago, relating to the general subject of agricultural education, and setting forth that plan by which, in my judgment, we can best meet and answer the real demands made upon us.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, April 20, 1874.

To the Honorable the Board of Regents:

Numerous indications, which need not here be enumerated, point to the necessity of developing so far as possible the genuine agricultural education called for in the act of 1862, donating lands to endow institutions now popularly known as agricultural colleges. Such, for example, are the pending congressional investigation into the condition and operations of the "Agricultural Colleges," the discussions carried on through the press, and the attitude of a powerful and organized body of farmers.

The experiments in agricultural education up to this time have been made along two lines:

Firstly; there have been numerous attempts to engraft it upon existing colleges or Polytechnic schools. In all, or nearly all these cases the agricultural course is merely a scientific course, more or less modified. The students entering upon it are few in number, and of inferior scholastic acquirements. These experiments have been so uniformly unsuccessful (so far as numbers of students indicate success,) as to arouse the suspicion, and in some cases, provoke the open charge that the funds are being used merely "to bolster up the old colleges." There is at present a decided reaction from a policy which I believe the wise and wholesome one, that of incorporating the Agricultural Colleges with the State Universities.

Secondly; there have been established a considerable number of independent agricultural colleges, some of which have obtained a wide reputation as successful and prosperous. I would not wish to disparage unjustly the status and claims of these institutions, but I think no harm can come from truthful statements respecting them. I have prepared lists of their requisites for admission and of the studies of the first year, an inspection of which, will show that these so-called colleges are admitting to so-called Freshman classes youth who have, as a general thing, only passed over the ordinary common school studies. As a matter of course, the work which such students can perform cannot be above the grade of high school work. A further inspection of the courses of study offered by the independent agricultural colleges will show that these institutions are, as a matter of fact, mere higher academies, seasoned more or less with agriculture, and garnished with horticulture. Institutions such as these cannot attract the most energetic and ambitious youths. I believe the charge to be true that they do not return a large proportion of *graduates* to the farms.

In general, the criticism to be passed upon the separate agricultural colleges is that as mere academics or scientific schools, they are superfluous. The academic work can be done cheaper and quite as well in High Schools. There is no just occasion for the isolation of farmer's boys and girls, as is implied in the current statement that Agricultural Colleges are needed to teach farm*ers* and not farm*ing*.

In the University of Minnesota we have at least avoided errors. We have not taken boys from the common schools and admitted them to a Freshman class. We have not advertised a High School Course as a College Course, nor granted Baccalaureate degrees to Sophomores. We have

not, as we might have done, enrolled students pursuing the usual Scientific Course as "Agricultural Students"

We have for five years steadily offered free instruction in scientific agriculture to all comers. In our Collegiate De partment we have constantly offered the appropriate scientific preparation for agricultural studies.

The question naturally arises why have there not been more applications for instruction in agriculture. One answer will be that we have not at any time been able to show what we could do. Without a laboratory, without a plant house, without an imposing display of apparatus, it has been impossible to convince the public that we were really prepared to do anything; whereas the fact is that we have always been ready to teach the essentials.

The opening of the next year will find us prepared, not only to do vastly more than heretofore, but to make it appear so. The laboratory, the plant house, the apparatus and library will speak for themselves what no amount of advertising can do. If any "new departure" can be made then I think will be the time to make it.

There is still one experiment which, I am convinced after long attention, can be undertaken with prospect of success.

Agricultural education, if not a misnomer, is, or ought to be, professional education. It is just as absurd to call a course of general scientific studies agricultural, as it would be to designate it medical, legal, musical or nautical.

Assuming, then, that agricultural education is professional, the question is, from what examples shall we draw the principles upon which to organize it? The answer is, clearly from existing professional schools in our own country. European precedents can aid but little, so different are European conditions from our own. Concerning our American professional schools, legal, medical and theological, it is to be remarked that they have in no case undertaken to give mere academical instruction of any grade. Collecting companies of young men desiring to enter the respective professions, and presuming them to have already acquired sufficient academical knowledge, these schools at once set about teaching them the principles and methods of their arts. Vulnerable as these institutions are in many points, I believe they have adopted the only practicable way to *begin* professional training. Ill-furnished as the majority of young men who resort to our law and medical schools are, no one who values a reputation for sanity would propose that the law and medical professors should teach them orthography, or syntax, or the binomial theorem.

Why should the Professor of Agriculture be asked to do this? And why should the Agricultural College be converted from a professional school to a mere unnecessary academy?

But can the Agricultural College be made in fact a professional school? Yes, by following the example of other schools—American professional schools.

I respectfully submit, therefore, the following suggestions:

1. That the Board of Regents offer a course of free professional instruction in Agriculture and Horticulture, beginning in November and ending in March, covering about 100 working days.

2. That there be formed a class, to be composed mainly of young men, either actually engaged in some branch of Agriculture, or intending soon to begin.

3. That the instruction be given partly by members of our permanent corps, and partly by lecturers brought from other quarters.

4. That such gentlemen as the following be employed as the lecturers: Professor Warder, on Horticulture; Professor Riley, on Entomology; John Stanton Gould, on Agricultural Machinery; Professor Laws, on Veterinary Science; Professor Miles, on General Agriculture. These names are suggested merely as representatives. From ten to twenty lectures might be had from each expert.

5. That the lectures be open to all comers; that no conditions be put upon admission, except a registration and a general pledge to punctual attendance; and that an examination be offered to all who may please to undergo it.

6. That if resolved upon, this plan be promptly and industriously advertised, and that arrangements be made for the maintainence of students from abroad at low rates.

The argument for this plan has been already made. It appears to be the last alternative. In my judgment it always was the best one. It proposes to go to work without any theory; to take such students as can be got and give them such instruction about their business as they desire to gain and are competent to acquire.

Respectfully submitted.

The attention of your honorable body is respectfully called to the accompanying communication from Mr. Lacy, who has since the close of the year taken charge of the Professorship of Agriculture. This paper embodies a report of Mr. W. T. Scott, the Superintendent of the Experimental Farm, containing the record of a considerable number of interesting experiments. Mr. Lacy submits a variety of valuable suggestions, and a detailed plan of operations in the College of Agriculture. These will at once commend themselves as worthy of mature consideration.

BUILDINGS.

In the last annual report, page 33, under the head of "Buildings" I used the following words: "Ample as the time may now seem, I am convinced that there is great danger that they may not be ready for occupancy by the opening of the year 1873-4." This apprehension, as the Board are well aware, has been more than realized. At the time named the walls of neither the agricultural college nor the addition to the main building were completed. Three months have passed and the latter is not wholly enclosed. The prospect is that neither of the buildings will be available during the current university year. This delay could be endured with less regret were it not for the fact that relying on the confident assurances of the contractor, the required alterations of the old building were carried out in the vacation. These embraced (1) the obliteration of the temporary chemical laboratory, (2) the opening of a main staircase for the whole building, thus cutting out a large space in each of the four floors, (3) the formation of a room for the department of physics, by uniting two of the former class rooms and a cross hall; (4) the division of the assembly hall by extending the main corridor of the third story so as to light the same.

The result of these alterations undertaken under an assurance that the new buildings would be ready without fail, has been, not only to reduce the working capacity of the old part of the building, but to totally prevent some work, such as analytical chemistry, from being carried on. I do not deem it worth while to make any report upon the condition of the chemical apparatus, most of which remains in the boxes. The geological collections still lie in the basement. Atten-

tion is respectfully called to the remarks of the Professor of Geology and Chemistry on these points.

LIBRARY.

The Library has been increased by a few donations an by the binding of periodicals supplied to the Reading Roon Appendix D. shows the accessions in detail, the list of don tions and other statistics. It is useless to recommer further additions or devise new plans and rules, until t rooms assigned to the Library and Reading Room in the ne building are in readiness. The usual appropriations a asked.

GEOLOGICAL SURVEY.

The reports of Professors Winchell and Peckham, he with transmitted, show the progress of this enterprise. T chemical investigations have been wholly suspended sin the obliteration of the old chemical laboratory already ferred to. The remarks of Prof. Winchell, in his report curator of the museum, deserve early consideration.

I am not informed as to the exact condition of the publ lands appropriated to the State for the purpose carrying c the geological survey, but I am of the opinion that as soc as sufficient funds can be accumulated, other branches of th survey should be undertaken. In particular, the botanica and entomological investigations should be systematicall begun. The topographical work, heretofore under my im mediate charge, the Board, at my request, have transferre to Professor Rhame, as being germain to the work of hi department, that of Civil Engineering. For some time thi branch of the Survey must be content with accumulating the material furnished by the State and Government surveys and those of the various railroad lines. After a few years means should be provided for making astronomical observa tions at numerous points, generally at county seats. Thes points may thereafter be connected by geodetical operations and thus a complete and perfect map of the whole Stat compiled. Since the last report, the United States Coas Survey has completed its reductions of Mr. F. Blake's obser vations for ascertaining the latitude and longitude of th University. The last report gave the results of simila observations by officers of the United States Lake Survey connected with the Engineer Bureau of the Army. A com

parison of the results is interesting as showing the skill of the observers, and the excellence of their instruments and methods. The figures are:

LATITUDE.

Coast Survey, - - -	44°	58′	37″.60
Lake Survey, - - -	44°	59′	39″.22

Difference, one and 62-100 seconds.

LONGITUDE.

Coast Survey, - - -	93°	14′	9″
Lake Survey, - - -	93°	14′	8″.6

Difference, four tenths of a second.

It must be borne in mind that the "stations" to which the measurements extend are not the same. The Lake Survey chose the cupola of the old building; the Coast Survey placed its station at a point on the campus distant 295.6 feet to the South, and 88.1 feet Eastward.

THE FUTURE.

In anticipation of the completion of the new buildings and the corresponding extension of our means of instruction, I offered in the last annual report a number of suggestions in reference to the future. (See pp. 86, and following.) Burdened as your honorable body is at the present time with wearisome delays and negotiations, I do not deem it proper to bring forward new projects. Permit me to refer you to the document just cited for suggestions relating to the management of the lands constituting the endowment; the prosecution of our claim for the equalization of the land grant of 1862; the establishment of an astronomical observatory; the opening of new Colleges and Departments; the organization of a Teachers' College; the appointment of non-resident Professors; the framing of Postgraduate Courses of instruction; the providing of lodging houses for young men; and the building of a Boarding Hall for young ladies.

There are, however, two items which seem to call for more emphatic mention at this time.

MILITARY SCIENCE.

In previous reports I have referred to the need of a Drill Hall for the Department of Military Science. In the last report in particular this matter was argued. I now respectfully recommend, that in the event of funds not being furnished by the State to build a suitable Drill Hall, that the Department of Military Science be promptly abolished.

DINING HALL.

The second item is the need of a Dining Hall, on or near the University grounds. Heretofore it has been possible to confine the public exercises of the University to one long forenoon session. It may be possible to continue that arrangement for one more year, but not much longer. As our work developes and new departments are organized, the programme will extend itself. It can not be many years before it will occupy the whole day. Now if our Professors and students lived in dwellings and dormitories on or near the University Campus, this would make no difference. But living as they do, the majority more than one mile away, and some five or six miles away, they cannot go and come between recitations. Students pursuing draughting or analytical chemistry or surveying, need to spend the entire day at the institution. A Dining Hall will enable this arrangement to be made. A similar combination of circumstances has already induced the trustees of the Massachusetts Institute of Technology at Boston to adopt this plan. It has worked successfully and satisfactorily. Such a Dining Hall economically managed would much simplify the problem of the maintenance of needy students, and the majority of ours are such.

I beg leave to close this report with reminding your honorable body that your gratuitous exertions in the management of the affairs of the University are put forth in the interest of the most worthy and deserving class of our youth—the sons and daughters of the working people—and I am bound to say that hitherto the bounty of which you are the almoners has been most worthily bestowed. All of which is respectfully submitted.

APPENDIX A.

BISHOP WHIPPLE'S ADDRESS.

Mr. President, Professors, and Students of the University of Minnesota: It is a great pleasure to be with you to-day. As your fellow-laborers in the cause of education, I offer you my congratulations upon the progress of our State University. There is no rivalry in educational work, except that generous emulation which helps us all to do our part well in building up institutions to bless the State.

When I came to Minnesota, the Episcopal Church had a university. Its buildings, endowments, libraries, museums, professorships, and students were a myth. It shared its paper honors with many kindred institutions. We had a few boys studying the "three Rs," a few more studying the rudiments of Latin and Greek. I knew that life was short, and that, in the West at least, time waits for no man. I knew we could not build houses from the chimney-top. We were poor, but we could be honest. I said, "We will have an honest school and call it by an honest name—a *school.*" I thought the public would honor a school which taught collegiate studies, but they might despise a university which kept a parish school. We parted with the university, but we have the school.

When I visited England, I found that England with thirty millions of souls had but four universities, Oxford, Cambridge, Durham, and London. Minnesota, with 200,000 souls, had half a score. But then it took England five hundred years to build an Oxford, and Minnesota has killed five in as many years. I visited such schools as Rugby and Eton, and asked the counsel of men who had made education a life-long work. They told me that even to build a *school* I must begin with a score of of boys; that a hundred boys would ruin me. A school was a living being; it had organized life. It grew. Its character was made up of the discipline, scholarship, morals, and traditions of all who became its pupils.

I came home a wiser man, and resolved that if it took twenty men like me to lay the foundation we would have one good English school. We lay no claim to peculiar wisdom. Each one must work out the problem in his own way. The field is wide enough for all. There is no need of jealousy or friction. If the plan is an honest plan to do good honest work in the sacred cause, it will be crowned with its measure of success, and from my heart I bid all such workers a hearty God-speed in doing all such work for God and man.

There are three institutions which God has given unto man—the family, the church, and the State. The teacher is God's trustee for each of these.

The State *must* have its common schools. Our divided Christianity cannot do this work even if it would. There is a morality which lies back of creeds. It never can be sectarian to teach children to a Christian State that there *is* a God. It is not sectarian in a Christian State to teach children reverence for God's eternal law. It is not sectarian in a Christian State to teach its children the obligations which grow out of the ties which God has given to bind us in social and civil bonds. Daniel Webster said that all the world had ever written of the source of authority of the law did not equal the majesty of one sentence of God's word, "There is one lawgiver and one Judge."

Each church ought, as far as it may, to mould and train its own children and teach them a definite faith. The denominational school will do this. It represents the parent during the child's tender years when character is being formed. There is the more need of the strict discipline of such schools in the hurry of our western life, where home training is so neglected. It gives character, culture, and Christian help at that period of life when Dr. Arnold was wont to say, "that all the powers of evil beleaguer the boy's soul to claim the mastery, and if by God's help he conquers, he is safe for time and eternity." *There is a higher culture which the university alone can give.* In a State where we are all of yesterday, everything is to be done, and we are too poor to provide the large endowments for libraries, laboratories, cabinets, apparatus, professorships, and lectureships of a university. The State can and ought to lay the foundations broad and deep enough to give children the ripest scholarship and make them the peers of all true scholars. She wrongs herself, she wrongs her children, she wrongs the unborn generations when she refuses to do this work. The position of our State is one of singu-

lar responsibility. God is sending to us the people of every tongue, and clime, and kin, and out of this fusion of the stocks of the old world there will grow in this northern clime a people more powerful for good or terrible for evil than any people on the face of the earth. We ask for this new race the means for the ripest culture in letters, science, and art. We do not ask the State to teach religion. She has done her work when she has recognized God, from whom she has received the charter of her rights, and has taugh her children those obligations to the eternal principles of right which are based upon God's eternal law. We can build our beautiful Christian temples beside the university walls. We can proclaim in them the Gospel of glad tidings; and when the time shall come that we are able, we can build our church colleges and make them training schools for our university, that we may send you scholarly Christian men to receive at your hands the crowning benefit of university culture, We can, by our Christian zeal, consecrate learning and so keep the children under their mother's care. I trust that no discord or strife may ever mar the work we are called to do, and that the day will come when every institution of learning in the State shall, in spirit at least, belong to one guild of earnest scholars. The board of trustees, the president, and professors deserve our thanks for what has been done under great difficulties. I trust that year by year will add to their crops of professors, and make their standard of scholarship still higher, and that while encouraging scientific pursuits for a materialistic age, they will not forget that classical training which nurtured the great names of the past, and gave other universities their proud fame.

Learning has a value to enlarge the soul even when it cannot be coined into the currency of the realm. There are practical things besides the handling of commodities, and there is a higher wisdom than to be rich. It is wise to educate men to lead and guide our development in the coming future. But it is not less wise to cherish for our children those stories of learning which have been garnered in the ages which have passed away. The statesmen who to-day rule the world once had the ripe training of universities, and like Gladstone can find solace amid the cares of State in the idyls of classic story.

Young gentlemen—you who go out from these walls are the arbiters of the future of your alma mater. Remember, what the author of the whole duty of men calls "a gentle-

man's high calling." Show men by word and deed that you have the honor of the university in your keeping. Be true scholars. In your studies of the mysteries of nature, the laws of science, and the problems of living life, stop not at the threshold of God's temple, but go in and worship with the heart of a forgiven child. Like Agassiz, that great man who has lately gone to his rest, when you learn the law bow your whole soul in humble homage to God who made the law.

Show the world that this university trains men—not men who curse and swear—not men who lie and cheat—not men who boast and bluster—not men whose honor consists in calling that "sharp" which God calls fraud—but men who believe in God, and are afraid and ashamed to sin—men who know how to live, and if need be will show men how to die—men who make life a real and manly thing, who consecrate social and civil works, and so day by day are preparing for a higher life beyond the grave.

1. MATHEMATICS AND ASTRONOMY.—PROFESSOR THOMPSON.

Subject.	Class.	No. Exercises.	No. Students.	Term.
Algebra	Fourth.	50	61	II.
Algebra, Advanced	Third.	50	40	III.
Algebra, Advanced	Second.	65	25	I.
Geometry, Plane	Third.	65	50	I.
Geometry, Solid	Second.	10	31	II.
Trigonometry, Plane	Second.	40	81	III.
Trigonometry, Spherical	Second.	40	26	III.
Analytical Geometry	First.	65	20	I.
Calculus, Differential.	Junior	65	4	I.
Calculus, Integral	Junior.	30	2	II.
Modern Geometry, &c.	Junior.	40	8	III.
Astronomy, Descriptive	First.	40	15	III.
Astronomy, Practical	Senior.	34	2	I.

2. CHEMISTRY AND PHYSICS—ASST. PROF. PECKHAM.

Subject.	Class and Section.	No. Exercises.	No. Students.	Term.
Chemistry, General	Second.	65	32	I.
Chemistry, Applied	Sec. Sci.	58	11	II.
Chemistry, Analytical	Jun. and Senior.	65	7	I.
Chemistry, Analytical	Sen. and First.	58	5	II.
Natural Philosophy	Fourth.	65	50	I.
Natural Philosophy	"	56	46	II.
Physics, Mechanical	First.	65	20	I.
Physics, Chemical	First Sci.	64	10	II.
Physiology	Sec. and Fourth.	40	37	III.

3. NATURAL SCIENCES.—PROFESSOR WINCHELL.

Subject.	Class and Section.	No. Exercises.	No. Students.	Term.
Geology	Junior Scientific.	58	4	II.
Botany, Structural	Third "	30	32	II. half.
" Systematic	" "	40	19	III.
Elements of Zoology	First.	40	23	III.
Physical Geography	Third "	55	55	I.
Meteorology	" "	38	29	I. 10 ex. II. half.
Mineralogy	Junior and Senior.	57	5	II.

4. ENGLISH.—PROFESSOR DONALDSON.

Subject.	Class and Section.	No. Exercises.	No. Students.	Term.
Hart's Composition	Fourth.	65	85	I.
English Composition	Fourth Sp.	40	6	III.
Rhetoric	First { Sci. Lit.	40	7	I.
Logic	First.	50	17	II.
English Literature	Junior.	65	4	I.
" "	"	50	4	II.
Rhetorical Exercises, oral	3 Upper.	39	24	I. II. III.
" " written	"	90	24	"
" " rehearsals	"	250	24	"
Elocution	Second.	10	31	II.
General History, Outlines of	Third.	40	35	III.

5. GERMAN—ASST. PROF. SAWYER AND OTHERS.

Subject.	Class and section.	No. Exercises.	No. Students.	Term.
Grammar (begun)	Fourth { Sci. Lit.	65	49	I.
Grammar (cont'd)	Fourth.	58	49	II.
Worman's Reader	"	0	33	III.
Lessing—Minna v. Barnhelm	Third { Sci. Lit.	65	23	I.
Schiller—Thirty Years' War	Third.	58	28	II.
Benedix—Comedy	"	40	23	III.
Grammar (begun)	Junior, & .	65	16	I.
Grammar (advanced)	"	58	14	II.
Schiller—Jungfrau v. Orleans.	'	40	12	III.
Goethe—Iphigenie	Senior, &c.	65	12	I.
Kant and Hegel	"	24	4	II.

6. FRENCH—PROFESSOR HUGGINS.

Subject.	Class and Section.	No. Exercises.	No. Students.	Term.
Fasquelle's Method, &c.	Second { Sci. Lit.	65	12	I.
Fasquelle's Method, &c.	Second.	58	12	II.
Fasquelle's Method, &c.	"	40	12	III.
Fenelon, Telemaque	First { Sci. Lit.	58	7	II.

Subject.	Class and Section.	No. Exercises.	No. Students.	Term.
Cæsar, De Bello Gallico.....	Fourth, Cl.	140	53	I. II and
Cicero, Orationes.....	" "	55	58	III.
"	Third "	65	27	I.
Virgil, Æneid	" "	115	27	II and III
Livy, Historia.....	Second "	115	17	II and III
Horace, Odes, Satires, Epistles	First "	140	11	I and II.
Latin Compositions	3 Lower.	140	11	I and II.
Roman History and Geography	First.			
" " " "	Second.			
Roman Literature.....	Junior.	10	4	III.
Tacitus, History.....	"	65	4	II.
Roman Antiquities.....	"			
Juvenal Satires.....	"	55	4	III.
Plantus, Captives.....	Senior.	55	1	I.

8. GREEK—PROFESSOR BROOKS.

Subject.	Class, &c.	No. Exercises.	No. Students.	Term.
Grammar and Reader..	Fourth, Cl.	180	10	I, II & I
Xenophon—Anabasis.	Third "	130	15	I & II.
Herodotus—History.....	Third "	50	12	III.
Homer—Iliad.....	Second "	130	13	I & II.
Grecian Hist. and Antiquities.	" "	10	13	III.
Essays.....	" "	5	13	III.
Demosthenes—Philippics.....	First "	65	5	II.
Æschylus—Prometheus	" "	53	5	III.
History and Geography.....	" "	7	5	III.
Æschylus—Prometheus	" "	65	3	I.
Greek Literature—Lectures...	Junior.	14	3	III.
Greek Literature—Reviews...	Junior.	14	3	III.
Aristophanes—Clouds.....	Senior.	55	1	II.
Aristophanes—Essays..... ...	"	3	1	II.
Greek Literature—Lectures...	"	13	1	III.
Greek Literature—Reviews...	"	13	1	III.

9. METAPHYSICS AND COMPARATIVE PHILOLOGY.—PROFESSOR CAMPBELL.

Subject.	Class and Section.	No. Exercises.	No. Students.	Term.
Science of Language.....	Junior.	24	4	II.
History of Philosophy.	Senior.	45	4	I.
Ontology.....	"	30	4	I.
Ethics and Evidences.....	"	36	4	II.
German Philosophy.....	"	24	4	II.
Natural Theology—Lectures..	"	12	4	III.

10. POLITICAL SCIENCE.—PROFESSOR DONALDSON AND MR FOLWELL.

Subject.	Class.	No. Exercises.	No. Students.	Term.
Political Economy.....	Senior.	20	2	III.
History of Civilization	Junior.	33	4	II.
Story on the Constitution	First.	65	16	I.
International Law.....	Senior.	25	2	II.
American Constitution..... ..	"	25	2	II.

11. ENGINEERING AND INDUSTRIAL DRAWING.—PROF. RHAM[illegible].

Subject.	Class and Section.	No. Exercises.	No. Students.	Term
Leveling and Use of Inst'ments	Junior.	30	2	I.
Topographical Drawing	"	35	3	I.
Mechanics	"	60	4	II.
"	"	60	3	II.,
Triangular Surveying	"	40	2	III.
Henck's Field Book	"	45	2	III.
Farm Surveying	Second, Sci.	24	22	III.
Descriptive Geometry	First "	60	6	II.
Drawing, Plane Problems	Second "	65	4	I.
" Elements	Third "	60	39	II.
" El'm'nt'ry Proj'ct'ns	Second "	60	6	II.
" Perspective	First "	45	6	III.

12. MILITARY SCIENCE.—LIEUT. HUGGINS, U. S. A.

Subject.	Class.	No. Exercises.	No. Students.	Term.
Squad Drill	Fourth.	10	40	I.
Company Drill	All Male.	18	145	I.
Battalion Drill	"	20	145	III.
Sabre Exercise	First.	6	25	II.
Lectures	Second.		6	II.

The lectures on military science by Professor Huggins, given in the Assembly Hall during the winter term, were listended to with interest by considerable audiences. The topics were:

1. History of the Art of War.
2. Principles of Strategy, illustrated by the Campaigns of Marengo, Waterloo, &c.
3. Grand Tactics, illustrated by the battles of Prague, Rossbach, &c.
4. Flanking Movements, illustrated by Sherman's Atlanta Campaign.
5. Influence of Railways and Telegraphs on the Art of War.
6. Influence of Improved Fire-arms on the Art of War.

Professor Hewitt visited the institution several times during the year and inspected the work of his department, but gave no lectures.

Lectures were delivered before the Literary Societies, in the course of the year, by the following gentlemen: Professors Thompson, Brooks, Peckham, Rev. D. R. Breed, and Hon. I. Donnelly.

APPENDIX C.

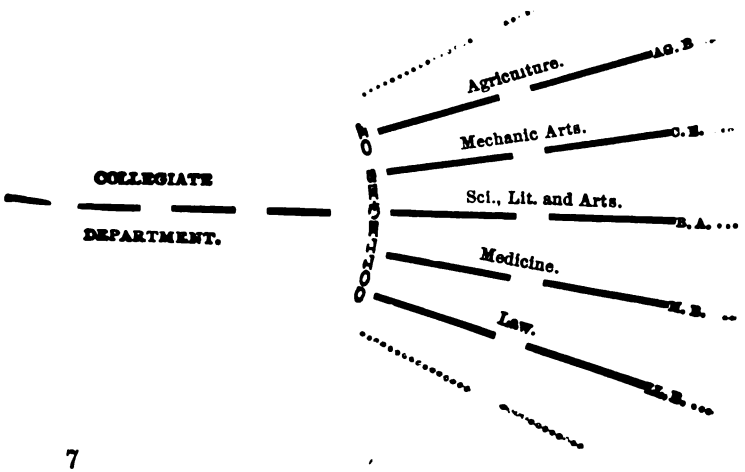
THE COURSES OF STUDY.

During the last two terms of the year the General Faculty, agreeably to a request of the Board of Regents, devoted a large amount of time and labor to a revision of the courses of study in the various departments.

The objects had in view in the revision were: (1) To provide for the better organization of certain departments not represented at the time the old courses were drawn up; (2) to harmonize and liberalize the disciplinary courses; (3) to adapt all courses to the advanced growth and condition of the institution. It is believed that the courses, as now readjusted, will remain essentially unchanged for a long time.

The general plan of the University remains the same as heretofore reported, the Colleges or Departments specified in the organic law retaining their respective relations.

The following diagram will illustrate these relations:



The schedules given below do not include the Colleges of Law and Medicine, which cannot yet, for want of means be organized. The departments provided for are—

1. The College of Science, Literature and the Arts;
2. The College of Agriculture;
3. The College of Mechanic Arts;
4. The Department of Elementary Instruction.

The last named, otherwise designated as the COLLEGIATE DEPARTMENT, is introductory to the permanent colleges of the University. It differs from the traditional "Preparatory Department" in that it includes the work of the two lower years of the usual college course. This arrangement emphasizes and formulates the prevailing tendency of American colleges and universities to make the close of the Sophomore year a branching point for certain technical and professional courses and for the introduction of elective studies. The High Schools and other "fitting schools" of the State are thus invited to extend their work up to this branching point, and thereby to liberate the University to carry on her appropriate work. When this shall have been generally done, the University will dispense with the department of elementary instruction as provided by law. One year's preparatory work has been dropped already, and another's has been ordered discontinued at the close of the year 1875-6.

As the Collegiate Department precedes the upper colleges in the order of time it is convenient to present its scheme of studies first. Attention is called to the following

GENERAL STATEMENTS.

1. The University year embraces 38 weeks exclusive of recesses, and is divided into three terms. The first term has fourteen weeks; the second and third, twelve each.

2. As a general rule each student, in whatever department, has three recitations a day for five days in the week, exclusive of rhetorical, military and other exercises.

3. The schedules are arranged according to the wants of the regular students. Special students must select from the studies as thus laid down.

4. Students of any department or college may attend classes of another department under the direction of the faculties.

5. Students in different courses are united in recitations whenever possible.

6. Elective studies, to count on standing, must be chosen from corresponding years and terms.

7. Applicants for advanced rank in any department must pass examinations in the subjects already gone over by their respective classes and sections.

8. *No honorary degrees are conferred by this University.*

9. Any person passing the required examinations will receive the appropriate degree.

10. The schedules present merely leading titles and subjects. The usual collaterals must in all cases be implied.

11. The rhetorical, military and other exercises are not specified, being held according to appointment of the Faculties from time to time.

I.

THE COLLEGIATE DEPARTMENT.

Applicants for admission are examined in—

Reading, Writing and Spelling;
English Grammar and Analysis;
Arithmetic and Elementary Algebra;
Geography and United States History.

Those who intend to pursue the Latin language are also examined in the Latin Grammar and Reader.

Three Courses of Study are offered:

I. The CLASSICAL Course, in which the ancient languages are prominent.

II. The SCIENTIFIC Course, distinguished by an unbroken series of elementary natural sciences.

III. The MODERN Course, in which the modern languages are conspicuous.

The Classical and Modern Courses offer as a general rule, two languages at once; the Scientific Course, but one, which may be English, or, if preferred, an ancient or a modern language.

No degrees are conferred in this department; students completing a course receive a certificate which entitles them to admission to any appropriate College of the University.

This department, as the common feeder of the higher departments, is controlled and managed by the General Faculty.

FOURTH CLASS,—(FIRST YEAR.)

	Classical Course.	Scientific Course.	Modern Course.
First Term.	1. Greek Grammar, (*begun.*)	1. Physical Geography.	1. History of England.
	2. English Composit'n.	2. English Composition.	2. English Composition.
	3. Cæsar,—*Gallic War.*	3. History of England, or Cæsar,—*Gallic War*, or Greek Grammar.	3. Physical Geography, or Cæsar,—*Gallic War*, or Greek Grammar.
Second Term.	1. Greek Grammar, (*continued.*)	1. Natural Philosophy.	1. English Language.
	2. Algebra.	2. Algebra.	2. Algebra.
	3. Cæsar,—*Continued.*	3. English Language, or Cæsar (*continued*), or Greek Grammar.	3. Natural Philosophy, or Cæsar (*continued*), or Greek Grammar.
Third Term.	1. Xenophon,—*Anabasis.*	1. Physiology.	1. Physiology.
	2. General History.	2. General History.	2. General History.
	3. Cicero,—*Orations.*	3. Elementary Astronomy, Cicero,—*Orations*, or Xenophon,—*Anabasis.*	3. Elementary Astronomy Cicero,—*Orations*, or Xenophon,—*Anabasis.*
		4. Free-Hand Drawing*	

* Optional in other courses.

THIRD CLASS,—(SECOND YEAR.)

	Classical Course.	Scientific Course.	Modern Course.
First Term.	1. Xenophon,—*Anabasis*	1. Natural Philosophy.	1. German (*begun*).
	2. Plane Geometry.	2. Plane Geometry.	2. Plane Geometry.
	3. Cicero,—*Orations.*	3. English,—*Readings.* German,—(*begun*), or Cicero,—*Orations*, or Xenophon,—*Anabasis.*	3. Natural Philosophy, or Cicero,—*Orations*, or Xenophon,—*Anabasis.*
Second Term.	1. Herodotus,—*History.*	1. Drawing (Geometrical)*—2 hours.	1. German,—*Grammar.*
	2. Geology,—*Elementary*	2. Geology—*Elementary.*	2. Geology,—*Elementary.*
	3. Virgil,—*Æneid.*	3. Modern History, German,—*Grammar*, or Virgil,—*Æneid*, or Herodotus,—*History.*	3. Modern History, or Virgil,—*Æneid*, or Herodotus,—*History.*
Third Term.	1. Botany,—*Elements.*	1. Botany,—*Elements.*	1. German,—*Selections.*
	2. Higher Algebra.	2. Higher Algebra.	2. Higher Algebra.
	3. Virgil,—*Æneid.*	3. Modern History, or Virgil,—*Æneid*, or German,—*Selections.*	3. Modern History, or Virgil,—*Æneid*, or Botany,—*Elements.*

* Required of whole class one hour as an exercise.

SECOND CLASS,—(THIRD YEAR.)

	Classical Course.	Scientific Course.	Modern Course.
First Term.	1. Homer,—*Iliad.* 2. Solid Geometry and Plane and Spherical Trigonometry. 3. Molecular Physics.	1. Molecular Physics. 2. Solid Geometry and Plane and Spherical Trigonometry. 3. English,—*Trench*, or German,—*Schiller*, or Homer,—*Iliad.*	1. German,—*Schiller.* 2. Solid Geometry and Plane and Spherical Trigonometry. 3. Molecular Physics, or Homer,—*Iliad.*
Second Term.	1. Homer,—*Iliad.* 2. General Chemistry. 3. Livy,—*History.*	1. Draughting (2 Hours). 2. General Chemistry. 3. Zoology,—*Elements*, or German,—*Goethe*, or Livy,—*History*, or Homer,—*Iliad.*	1. German,—*Goethe.* 2. General Chemistry. 3. Zoology,—*Elements*, or Livy,—*History*, or Homer—*Iliad.*
Third Term.	1. Grecian Antiquities. 2. Conic Sections and Surveying. 3. Livy,—*History.*	1. Applied Chemistry. 2. Conic Sections and Surveying. 3. English,—*Readings*, or German,—*Selections*, or Livy,—*History*, or Grecian Antiquities.	1. German,—*Prose Selections.* 2. Conic Sections and Surveying. 3. Applied Chemistry, or Livy,—*History*, or Grecian Antiquities.

FIRST CLASS,—(FOURTH YEAR.)

	Classical Course.	Scientific Course.	Modern Course.
First Term.	1. Horace,—*Odes and Satires.* 2. Logic. 3. French (*begun*) or Analytical Chemistry, or Military Engin'r'ng	1. Mechanical Physics. 2. Analytical Chemistry. 3. Logic. 4. French (*begun*), or Horace,—*Odes, &c.*, or Military Engineering.	1. French (*begun*). 2. Logic. 3. Analytical Chemistry, or Horace,—*Odes, &c.*, or Military Engineering.
Second Term.	1. Demosthenes,—*Philippics.* 2. Descriptive Astronomy. 3. Horace,—*Satires and Epistles.*	1. Descriptive Geometry. 2. Descriptive Astronomy 3. French (*continued*) or Horace,—*Epistles*, or Demosthenes, or Military Engineering.	1. French (*continued*). 2. Descriptive Astronomy. 3. Horace.—*Epistles*, or Demosthenes, or Military Engineering.
Third Term.	1. Greek,—*One Tragedy.* 2. Rhetoric. 3. Zoology, or French-*Selections*, or German do.	1. Descriptive Geometry and Perspective. 2. Rhetoric. 3. Zoology, or French,—*Selections*, or Greek,—*A Tragedy.*	1. French,—*Selections.* 2. Rhetoric. 3. Zoology,—or Greek,—*A Tragedy.*

II.

THE COLLEGE OF SCIENCE, LITERATURE AN THE ARTS.

There are three undergraduate courses of study havi the same names as those of the Collegiate Department, b offering an extended range of optional or elective studie Each student takes at least three studies, two of which a required, the other, or others optional.

Students who complete the respective courses in a sati factory manner are entitled to receive the following degree

For the classical course the degree of Bachelor of Art
For the scientific course the degree of Bachelor of Science
For the modern course the degree of Bachelor of Literatu

Applicants for admission who bring a "Final Certificat from the Collegiate Department, are admitted without furth examination. Other applicants must pass examinations all the studies of the course chosen.

This college is under the immediate control of its Spec Faculty.

JUNIOR CLASS.

	Classical Course.	Scientific Course.	Modern Course.
First Term.	1. Plato,—*Crito*, &c. 2. English Literature. 3. Anal. Geometry and Calculus, or German, or French, or Analytical Chemistry, or Art of War.	1. Analytical Geometry and Calculus. 2. English Literature. 3. Plato,—*Crito*, &c., or German, or French, or Analytical Chemistry, or Art of War.	1. German,—*Schiller*. 2. English Literature. 3. Plato,—*Crito*, &c., Anal. Geometry an Calculus, or French, or Analyt. Chemistry, Art of War.
Second Term.	1. Tacitus,—*History*. 2. Comp. Philology(2) Hist. of Civilization (3). 3. Lithological Geology,or German (3) and English Lit. (2) or French, or Calculus (*continued*) or Military History.	1. Lithological Geology. 2. Comp. Philology, (2) * Hist. of Civilization, (3) 3. Tacitus,—*History*, or Germ.(3) & Eng. Lit.(2) or French, or Calculus (*continued*) or Military History.	1. German (3),—*Schill* English Literature (2. Comp. Philology 2) Hist. of Civilization 3. Tacitus,—*History*, o Lithological Geolog French, or Calculus, or Military History.
Third Term.	1. Greek, Lectures on Art. Latin,—*Juvenal*. 2. Psychology. 3. Historical Geology, or German and Eng. Lit. or French, or General Theory of Equations, &c., or Analytical Chemistry,or Military Law.	1. Historical Geology. 2. Psychology. 3. Greek & Latin, or German and Eng. Lit. or French, or General Theory of Equations, &c., or Analytical Chemistry, or Military Law.	1. German (3),—*Goeth* English Literature 2. Psychology. 3. Historical Geology, Greek and Latin, o French, or Gen. Theory of Eq tions, &c., or Analyt. Chemistry, Military Law.

*Indicates No. exercises per week when other than five.

SENIOR CLASS.

		Classical Course.	Scientific Course.	Modern Course.
First Term.	1.	Plautus,—*Captives*, &c.	Practical Astronomy.	Elements of Criticism.
	2.	Ontology and History of Philosophy.	Ontology and History of Philosophy.	Ontology and History of Philosophy.
	3.	Practical Astronomy, or Elements of Criticism, or French, or Scandinavian Languages, or Analytical Chemistry.	Plautus,—*Captives*, &c. or Elements of Criticism, or French, or Scandinavian Languages, or Analytical Chemistry.	Plautus,—*Captives*, &c. or Practical Astronomy, or French, or Scandinavian Languages or Analytical Chemistry.
Second Term.	1.	Aristotle,—*Ethics*. Lectures on Greek Literature.	American Constitution.	American Constitution.
	2.	Ethics and Evidences.	Ethics and Evidences.	Ethics and Evidences.
	3.	American Constitution German, or Italian.	German, or Aristotle and Greek Literature, or Italian.	German, or Aristotle and Greek Literature, or Italian.
Third Term.	1.	Political Economy.	Political Economy.	Political Economy.
	2.	International Law, (2) Fine Arts, (1) Sanitary Science, (1) Natural Theology, (2) Greek, (1) Latin, (1) Modern Languages. (2)	International Law, (2) Fine Arts, (1) Sanitary Science, (1) Natural Theology, (2) Greek, (1) Latin, (1) Modern Languages. (2)	International Law, (2) Fine Arts, (1) Sanitary Science, (1) Natural Theology, (2) Greek, (1) Latin, (1) Modern Languages (2).

III.

THE COLLEGE OF THE MECHANIC ARTS.

There are three undergraduate courses of study leading to appropriate degrees, to wit:

(1) A course of Civil Engineering leading to the degree of Bachelor of Civil Engineering;

(2) A course in Mechanical Engineering leading to the degree of Bachelor of Mechanical Engineering;

(3) A course in Architecture leading to the degrees of Bachelor of Architecture.

The studies are partly prescribed, and partly elective; the latter may be chosen from corresponding terms and years in other colleges.

Applicants who bring a "Final Certificate" for the Scientific Course of the Collegiate Department are admitted with-

out further examination. Other applicants must pass examination in all the studies of said course.

This College is under the immediate control of its Special Faculty.

JUNIOR CLASS.

	Civil Engineering.	Mechanical Engineering.	Architecture.
First Term.	1. Higher Surveying and Leveling, Topographical Draw'g.	1. Machinery,—Use of Lathe, &c. Mechanical Drawing.	1. History of Architecture Architectural Drawing
	2. Differential Calculus.	2. Differential Calculus.	2. Differential Calculus.
	3. Elective.	3. Elective.	3. Elective.
Second Term.	1. Analytical Mechanics, Shades, Shadows and Perspective.	1. Analytical Mechanics. Shades, Shadows and Perspective.	1. Analytical Mechanics. Shades, Shadows and Perspective.
	2. Integral Calculus.	2. Integral Calculus.	2. Integral Calculus.
	3. Lithological Geology.	3. Lithological Geology.	3. Elective.
Third Term.	1. Geodesy, with field practice.	1. Motors,— *Hydraulic, Steam, &c.*	1. Constructions, with Drawing.
	2. Gen. Theory of Equations and Mod. Geometry.	2. Gen. Theory of Equations, and Modern Geometry.	2. Ventilation and Heating.
	3. Elective.	3. Elective.	3. Elective.

SENIOR CLASS.

	Civil Engineering.	Mechanical Engineering.	Architecture.
First Term.	1. Field Engineering— *Railway Work, with Drawing.*	1. Machinery, with drawing.	1. Architectural Designing— *with Drawing.*
	2. Applied Mechanics— (*Strength and Stress of Materials.*)	2. Applied Mechanics— (*Strength and Stress of Materials.*)	2. Applied Mechanics— (*Strength and Stress Materials.*)
	3. Practical Astronomy.	3. Practical Astronomy.	3. Elective.
Second Term.	1. Engineering Structures: (*Framing, Bridges, &c.*)	1. Mechanical Constructions.	1. Engineering Structures (*Framing, Roofs, &c.*)
	2. Stereotomy, with Drawing.	2. Stereotomy, with Drawing.	2. Stereotomy, with Dra ing.
	3. Elective.	3. Elective.	3. Elective.
Third Term.	1. Building Materials— (*Woods, Stones, Bricks, Mortars and Cements.*)	1. Building Materials— (*Woods, &c.*)	1. Building Materials— (*Woods, &c.*)
	2. Analytical Mechanics.	2. Analytical Mechanics.	2. Specifications, Estimat &c.
	3. Elective.	3. Elective.	3. Elective.

IV.

THE COLLEGE OF AGRICULTURE.

There are two courses of study; (1) The regular undergraduate course, of equal rank with the courses in the other Colleges, and leading to the degree of Bachelor of Agriculture; (2) The Elementary Course, coinciding in the main with the Scientific Course of the Collegiate Department. Students who complete either of these courses are admitted to the advanced course without further examination.

Applicants for admission to the Elementary Course are examined in the following studies:

Reading, Writing and Spelling;
English Grammar and Analysis;
Arithmetic and Elementary Algebra;
Geography and United States History;

While the above courses of study are provided for those who desire a systematic education in Scientific Agriculture, the Board of Regents provide in their By-Laws for the admission of *any persons* to *any class* upon the sole condition that they appear to be competent to receive the instruction.

This College has a special building for its accommodation, containing a chemical laboratory and a plant house. There is an experimental farm of 120 acres.

This College is under the immediate control of its Special Faculty.

1. REGULAR COURSE.

	First Term.	Second Term.	Third Term.
Junior Class.	1. Analytical Chemistry.	1 Comparative Anatomy and Physiology.	1. Stock Breeding and Veterinary Science.
	2. Farm Engineering and Architecture.	2. Agricultural Chemistry, (*Analysis of Soils, etc.*)	2. Systematic Botany.
	3. Electives.	3. Lithological Geology.	3. Electives
Senior Class.	1. Economics, (*Accounts, Wages, Markets, &c.*)	1. Jurisprudence, (*Land Titles, Highways, etc.*)	1. Landscape Gardening and Horticulture.
	2. Arboriculture.	2. Climatology and Meteorology.	2. Special Agriculture of Minnesota.
	3. Dairying, Poultry Culture, Fish Culture, and other specialties.	3. Electives.	3. Electives.

2. ELEMENTARY COURSE IN AGRICULTURE.

Class	First Term.	Second Term.	Third Term.
Fourth.	1. Physical Geography.	1. Natural Philosophy.	1. Physiology.
	2. English Composition.	2. Algebra.	2. General History.
	3. History of England.	3. English Language.	3. Element'y Astronomy.
Third.	1. Natural Philosophy.	1. Elements of Geology.	1. Botany.
	2. Plane Geometry.	2. Mechanical Drawing, (2 Hours).	2. Higher Algebra.
	3. English,—*Readings*, or German, (*begun*).	3. Modern History, or German (*continued*).	3. Modern History, or German,—*Selections*.
Second.	1. Molecular Physics.	1. General Chemistry.	1. Applied Chemistry.
	2. Solid Geometry and Trigonometry.	2. Elements of Zoology.	2. Farm Surveying and Drainage.
	3. English,—*Trench*, or German,—*Schiller*,	3. Drawing, German,—*Goethe*.	3. English,—*Readings*, German,—*Selections*.
First.	1. Mechanical Physics.	1. Stock Breeding and Veterinary Science.	1. Entomology.
	2. Analytical Chemistry.		
	3. Logic.	2. Meteorology and Climatology.	2. Rhetoric.
	4. Military Engin'ring, or French (*begun*).	3. Military Engin'ring, or French (*continued*).	3. Zoology, or French,—*Selections*.

Students so preferring, are at liberty to pursue either of the ancient languages as laid down for the Classical Course in the Collegiate Department.

APPENDIX D.

LIST OF DONATIONS

To the Library of the University of Minnesota, from July 1st, 1873, to June 30th, 1874.

Mr. Thomas Bennett, of Ontario,
1 vol. Bullion's English Grammar.
1 vol. Catalogue Presbyterian Board of Publication.
3 vols. Calvin, J., Commentary on the Psalms.

Mr. Clark Stewart,
1 vol. James, The Young Woman's Friend.
1 vol. Wilson, Lights and Shadows of Scottish Life.
1 vol. Disraeli, Lothair.
1 vol. Greenleaf, Practical Treatise on Algebra.
1 vol. Sprague, A. W., Elements of Natural Philosophy.
1 vol. Neill, John, True Womanhood.
1 vol. Cheever, J. B., Journal of the Pilgrims of Plymouth.

Mr. N. Kolkin,
1 vol. Lesage, Historie de Gil Blas.
1 vol. Hall, John, Successful Preaching.
1 vol. Monod, A., Ist die Bibel von Gott.
1 vol. Pontoppidan, Oppaekelige Hyrde Breve.
1 vol. Barth, C. G., Geschichte der Christlichen Kirche.
1 vol. Lodemann, A., German Conversation Tables.
1 vol. Arnd, Johann, Erstes Buch von wahren Christenthum.
1 vol. " " Zweites " " " " "

Mr. Wm. W. Folwell,
11 vols. Miscellaneous.

Hon. Alex. Ramsey,
2 vols. Medical and Surgical History of the War of the Rebe
1 vol. Ninth Census of U. S., Population and Statistics.
1 vol. " " " Industry and Wealth.
1 vol. " " " Social Statistics.
5 vols. Messages and Documents, Dept. State, Part II, vo
2, 3, 4, 5, 1872-3.
3 vols. Congressional Globe, 3d sess. 42d Cong., 1872-3.
1, 2, 3.
1 vol. United States Coast Survey, 1870.
1 vol. Ninth Census of United States, 1870. Industry and We
1 vol. (unbound) Official Gazette U. S. Patent Office, vol. V.
19 pamphlets. Reports of Depts. of U. S. Govt. for 1873.
25 Miscellaneous pamphlets.

Hon. C. Delano, Secretary of the Interior,
1 vol. Synopsis of Acrididae of North America.
1 vol. Contributions to the Vertebrate Fauna of Western T
tories.
1 vol. United States Survey of the Territories for 1867, 8, 9.
1 vol. Finance Report for 1873.

Hon. F. Watts, Commissioner of Agriculture,
1 vol. Report for 1872.

Mr. T. P. A. Howe,
1 vol. Warren, B., Helps to Education in the Homes of
Country.

Rear Admiral Sands, U. S. N.,
1 vol. Washington Astron. and Meteor. Observations for 187

Prof. N. H. Winchell,
1 vol. Pidgeon, Traditions of Decoodah.
1 vol. Flint, S., History and Geography of the Mississippi Val

Mr. John Lewis Peyton, England,
1 vol. Peyton, J. L., Memoir of William Madison Peyton.

Columbia College, New York, through President Barnard,
1 vol. Life and Correspondence of Samuel Johnson, D.D.

Rev. D. Stewart, D. D.,
26 vols. German books on Philology and Theology.

Hon. S. P. Jennison, Secretary of State,
12 vols. Minnesota Ex. Documents, 1873.

Hon. J. S. Pillsbury,
2 vols. Minnesota Ex. Documents, 1872.
33 Miscellaneous Pamphlets.

Maj. Gen. A. A. Humphreys, Chief of Engineers, U. S. A.,
1 vol. Tables useful in Surveying, Astronomy, &c.
1 vol. Report of Chief of Engineers for 1873.

Mrs. Mary Dix Van Dyke, Wabasha,
1 vol. Strong, S., Treatise on the Differential Calculus.

United States Government,
1 vol. Report of Commissioners of Internal Revenue.
1 vol. Acts U. S. passed 3d sess. 41st Cong. and 1st sess. 42d Cong.
1 vol. Boutwell's Direct and Excise Tax of the United States.
1 vol. Ku Klux Conspiracy. Report of Commissioners.
1 vol. Reports upon the Mineral Resources of the U. S.
4 vols. Congressional Globe, 1863–4, 1st sess. Parts I, II, III, IIII.
2 vols. Congressional Globe, 1864–5, 2d sess. Parts I, II.
1 vol. Report of Commissioner of Internal Revenue, 1871.

LIST OF BOOKS

Issued to Students during year Sept. 16th, 1873, to Jun 19th, 1874.

	First Term.	Second Term.	Third Term.	Totals.
History	48	58	33	139
Biography	30	41	12	83
Novels	42	41	13	96
Metaphysics	13	15	5	33
Belles Lettres. Prose	43	43	15	101
Belles Lettres. Poetry	62	30	15	107
Anc. Languages and Lit.	18	15	8	41
Modern " "	39	35	18	92
Nat. Science and History	45	40	21	106
Mathematics	23	13	7	43
Travels	45	36	18	99
Political Science	8	11	4	23
Miscellaneous	62	28	13	103
Totals	478	406	182	1066

Total No. Books issued for Home Reading during year..... 1,
Total No. Books issued for Reading Room during year.....
Total No. Books issued to Faculty during year.....

1,

LIST OF PERIODICALS

Received at the Reading Room during the year 1873-4.

QUARTERLY.

Journal of Speculative Philosophy.
New Englander.
North American Review.
Edinburgh Review.
British Review.
Westminster Review.
London Review.
International Review, (six times a year.)

MONTHLY.

American Journal of Science and Art.
American Agriculturist.
Journal of the Franklin Institute.
Van Nostrand's Electic Engineering Magazine.
Appleton's Popular Monthly Science.
Scribner's New Monthly.
Harper's New Monthly.
Sunday Magazine.
Blackburn's Magazine.
Eclectic Magazine.
Minnesota Teacher.

WEEKLY.

The Nation.
Littell's Living Age.
New York Tribune.
Army and Navy Journal.
Appleton's Journal.
Harper's Weekly.

*Nordisk Folksblad.
*Farmer's Union.
*Glencoe Register.
*Mower County Transcript.
*Fergus Falls Journal.

SEMI-WEEKLY.

*New York Evening Post.

DAILY.

*Minneapolis Tribune.
*Saint Paul Press.
*Duluth Herald, (part of the year.)

*Supplied gratuitously by the Publishers.

LIST OF BOOKS PURCHASED AND PRESENTED, MARCH, 1872–DECEMBER, 1874.

ABBOTT, E. A.....A Shakespearean Grammar. An attempt to illustrate some of the differences between Elizabethan and Modern English.... New Edition, London. Macmillan & Co., 1873....16mo. pp. xxiv. 511. (3208) 357.2

ABERDEEN University Calendar for the year 1869–70. * * *....1869. 12mo. [In Two Parts.] (3105) 358.6

ABERNETHY, John. Surgical Observations on the Constitutional Origin and Treatment of Local Diseases, and on Aneurisms....Eighth Edition. London: Longman....1825. 8vo. [*Vol. I. only.*] (2927) 153.23

ADAMS, Daniel, *M.D.*.....Arithmetic,....Analytically explained and systematically applied. Illustrated by copious examples....Boston:.... Phillips & Sampson, 1848. 12mo. pp. 306. (3178) 357.18

AGASSIZ, Louis [Jean Rudolph]. Geological Sketches. * * * Boston: James R. Osgood and Company,....1873. 12mo. pp. iv . 311. (3234) 357.25

AHN, F. A New, Practical, and Easy Method of Learning the German Language....Second Course. Ninth Edition. Philadelphia:....John Weik & Co., 1858. 16mo. pp. 108. [*First Course wanting.*] (35) 245.25

AIRY, George Beddell....On Sound and Atmospheric Vibrations with the Mathematical Elements of Music. Second Edition. London: Macmillan & Co., 1871. 16mo. pp. xvi . 280. (2855) 65.14

AMELY, J. Military Maxims of Napoleon. Translated from the French. New York: Wiley & Putnam, 1845. 12mo. pp. 81. (3082) 356.29

ALCOTT, William A....Tea and Coffee: their Physical, Intellectual and Moral Effects on the Human System. Fifth Stereotype Edition. New York: Fowlers & Wells. n. d. sm. 12mo. pp. 99. (2057) 358.18

ALEXANDER, J. H. *See* Simms, F. W.

ALISON, A. *See* Jeffrey, F.

ALLEN, Joseph H., and Greenough, James B. A Latin Grammar for Schools and Colleges, Founded on Comparative Grammar. Boston Ginn Brothers.... 1874. 12mo. pp. xv . 266. (3258) 256.1

ALSOP, A. *See* Taylor, *Rev.* H.

ALVARES, D. Levi.... Esquisses Historiques ou Cours Methodique D'Histoire.... Nouvelle Edition.... A Paris chez L'auteur.... n. d sm. 12mo pp. 396. (3189) 358.1

AMERICAN Peace Society, Boston, Mass. Peace Principles Safe and Right. [*A collection of articles on Peace; no title page.*] 12mo (2937) 245.1

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TOMLINSON, Charles. A Rudimentary Treatise on Warming and V tilation;....Sixth edition, with copious Index. * * * Lond Virtue & Co....1869. 24mo. pp. xi . 339. [*Plates.*] [*Weale's R mentary Series, 57.*] (3242) 357

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TEMPLE, *Sir W*[illegible]
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Vol. IV.—Report on Mining, [illegible] H. F. Q. D'Aligny; Report upon Building Materials, and Methods of Building: by J. H. Rowell: Report on Beton-Coignet, by L. F. Beckwith: Report on Asphalt and Bitumen, by A. Beckwith: On Civil Engineering and Public Works, by W. P. Blake: Report upon Steam Engineering, by W. S. Auchincloss: Examination of the Telegraphic Apparatus and the Processes in Telegraphy, by S. F. B. Morse. Vol. V.—Reports on Cereals, by S. B. Ruggles and G. S. Hazard; Report upon Musical Instruments, by P. Stevens; Report on Instruments and Apparatus of Medicine, Surgery and Hygiene, by T. W. Evans; Report on the Preparation of Food, by W. E. Johnson; Report on the Manufacture of Pressed or Agglomerated Coal, by H. F. Q. D'Aligny; Report upon the Culture and Products of the Vine, by M. P. Wilder, A. Thompson, W. J. Flagg, and P. Barry; Photographs and Photographic Apparatus, by H. F. Q. D'Aligny; Outline of the History of the Atlantic Cables, by Henry F. Q. D'Aligny; Report on School Houses, by J. R. Freeze; Report on the Munitions of War, by C. B. Norton; The Manufacture of Beet Sugar and Alcohol, and the Cultivation of Sugar Beet, by H. F. Q. D'Aligny.

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[*Each volume is complete, but topics have been inverted by binder.*]

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TESTAMENTS. *See* Bibles and Testaments.

REPORTS

OF THE

PROFESSORS OF THE UNIVERSITY.

PROFESSOR CAMPBELL'S REPORT.

UNIVERSITY OF MINNESOTA,
June 30, 1874.

To the President of the University:

SIR:—The students of the University who are pursuing studies in the College of Science, Literature and the Arts, enter my classes the second term of the junior year and continue under my instruction throughout the remainder of their course. At the opening I begin a course of lecture on Philology (theoretical, not comparative,) aiming to give the theory or science of language in its general principles. These lectures occur twice a week. While there is some reference to the laws of *different* languages, this reference is by way of illustration and does not require previous study of these languages, or even a comparison of them on the part of the student. The lectures, however, are so arranged that they are adapted to students who have a thorough knowledge of English only, as well as to those who are pursuing the study of foreign languages. The main object of these lectures is to lead the student into the study of mind through the portal of speech.

The succeeding term the class enters upon the study of Psychology, making daily recitations from the text books which are accompanied by lectures.

The method of this investigation of the mind is inductive—science proper—and aims to classify the facts of conscious-

ness and thus prepare for beginning the study of philosophy (proper) with the senior year.

Ontology and the history of philosophy are pursued together. In other words the principles and results of philosophy are reached historically. The instruction is given by lectures, four in each week. Once a week a recitation is held for the review of the four lectures. The history of philosophy is brought down to the present day and ends with a summary of the views of the men who now occupy the chairs of philosophy in the leading Universities of the world. The lectures occupy a part of the second term also, and are followed by a course on Ethics. This is a practical application of the principles of philosophy, just developed, to the regulation of men individually, socially, politically and religiously.

The second term (senior—five times per week) concludes with some inquiries, philosophical and historical, into the evidences of revealed religion. The last term of the senior year an optional course of lectures is offered on Natural Theology. This course is intended to supplement the philosophy of right by an investigation of the philosophical arguments for the existence of a supreme being, a personal, moral governor of the universe. In this way the student is conducted over the whole field of human thought, and is given an insight into the great systems of truth as they have been developed in the progress of the race. In studying the German philosophy, the class (all of whom were familiar with the German language) pursued the outline of Kant and Hegel in the original German, as given by Schwegler in his *Geschichte der Philosophie;* and for an aid in the understanding of the Greek philosophy, the professor of that language has arranged his course so as to give the classical students practice in translating Plato and Aristotle. It is my aim to establish in the University superior facilities for the study of philosophy, a subject in which America is so sadly deficient. All of which is respectfully submitted.

G. CAMPBELL,
Professor of Mental and Moral Philosophy.

PROFESSOR WALKER'S REPORT.

UNIVERSITY OF MINNESOTA,
June 30th, 1874.

the President of the University:

IR: I have the honor to submit the following report of department of latin language and literature for the Uni-ity year of 1873–4.

NUMBER OF STUDENTS.

Collegiate Department.

Class,	53	
Class,	28	
lass,	17	
ass,	11	—109

College of Science, Literature, and Arts.

iors,	4	
iors,	1	— 5
		114

he work of the department has been as follows:

I TERM.

Class, 2 Sections, Cæsar, Latin Grammar and Composition.
Class, 1 Section, Cicero, Latin Grammar and Composition.
Class, 1 Section, Horace and Antiquities.
iors, Plautus's Comedies.

II TERM.

Class, 2 Sections, Cæsar, Latin, Grammar and Composition.

II Class, 1 Section, Livy and Roman History.
Juniors, Juvenal's Satires and Lectures on Latin Literature.

Assistance by Asst. Prof. Helen Sutherland.

I TERM.

IV. Class, 2 Sections, Cæsar, Latin Grammar and Composition.

II TERM.

IV Class, 2 Sections, Cæsar, Latin Grammar and Composition.
III Class, 1 Section, Virgil, Latin Grammar and Composition.

III TERM.

IV Class, 2 Sections, Cicero, Latin Grammar and Composition.

V. J. WALKER,
Prof. of Latin Language and Literature.

PROFESSOR BROOKS' REPORT.

To the President of the University:

SIR:—I have the honor to present the report of work and of the Department of Greek for the year ending June 18, 1874. The accompanying scheme will give the details:

Subject	Class.	No. Exercises.	No. Students.
Grammar and Reader, - -	IV	180	10
Xenophen—Anabasis, -	III	130	15
Herodotus—History, - -	III	50	12
Homer—Iliad, - - -	II	130	13
Grecian Antiquities, - -	II	30	13
Grecian History and Geography,	II	10	13
Essays, - - - - -	II	5	13
Demosthenes—Philippics,	I	65	5
Æschylus—Prometheus, - -	I	53	5
History and Geography, -	I	7	5
Æschylus—Prometheus - -	Jun.	65	3
Greek Literature—Lectures,	Jun.	14	3
Greek Literature—Reviews,	Jun.	14	3
Aristophanes—Clouds, - -	Sen.	55	1
Essays, - - - - -	Sen.	3	1
Greek Literature—Lectures,	Sen.	13	1
Greek Literature—Reviews,	Sen.	13	1

It is proper to say that instruction was given to the Junior class in Prometheus by the President one term; by Mr. Moore, to the II class on Greek Antiquities, one half term; by Mr. Hutchinson, on Greek Grammar and Reader two terms.

With great respect,

JABEZ BROOKS,

Professor of Greek

University of Minnesota, June 18, 1874.

PROFESSOR THOMPSON'S REPORT.

To the President of the University of Minnesota:

SIR. I have the honor to submit the following report of the Department of Mathematics and Astronomy for the University year of 1873–4.

The work has been as follows:

I. TERM.

			Students.
III Class,	2 Sections,	Plane Geometry,	50
II Class,	1 Section,	Bourdon,	25
I Class,	1 Section,	Analytical Geometry,	20
Junior Class,	1 Section,	Differental Calculus,	4
Junior Class,	1 Section,	Integral Calculus,	2
Seinor Class,	1 Section,	Practical Astronomy,	2

II TERM.

			Students.
IV Class,	2 Sections,	Algebra,	56
III Class,	1 Section,	Bourdon,	41
II Class,	1 Section,	Solid Geometry,	30
II Class,	1 Section,	Plane Trigonometry,	31

III TERM.

			Students.
IV Class,	1 Section,	Algebra,	44
III Class,	1 Section,	Spherical Geometry,	23
II Class,	1 Section,	Spherical Trigonometry,	24
I Class,	1 Section,	Astronomy,	15
Junior Class,	1 Section,	Theory of Equations,	3
Junior Class,	1 Section,	Modern Geometry,	4

With the exception of one class during the third term, each of the above classes has recited every day throughout the corresponding term.

Valuable assistance has been rendered by Prof. Huggins, who has heard one class recite during the first and second terms. The remainder of the work has been performed by the Professor in charge of the department. A glance at these statistics must convince the candid mind that even now a permanent assistant is needed in order to discharge thoroughly the work of this department.

I think no other demands it more. To provide a student instructor one term, and a different student another term does not, and cannot answer the purpose.

It may happen that such an one is well qualified, but it is far more likely to occur that instruction from such sources is of little value. I would therefore recommend that the Board of Regents appoint an assistant instructor in this

department, as it already has done in the department of Latin.

There is still great lack of apparatus to successfully carry forward the work in all of its branches; this, I have no doubt, will be supplied as soon as the funds of the University warrant the expenditure.

I desire specially to call your attention to a change* in the course of study in this department, which I deem of essential importance, and which I trust the Board will order at its next meeting. As the course of study is at present arranged the "Second" class are all required to pursue Analytical Geometry during the third term. Instead of this, I think it would be better to require of all this class the geometrical treatment of Conic Sections, and to make Analytical Geometry a required study only in the scientific course, and have it immediately precede the differential calculus in the Junior class.

All of which is respectfully submitted.

E. J. THOMPSON,
Professor of Mathematics and Astronomy.

PROFESSOR HUGGINS' REPORT.

To the President of the University:

SIR:—I have the honor to submit the following report for the Department of Military Science and Tactics, during the University year ending June 18, 1874.

Drill commenced in the second week of the fall term, the male students, with the exception of the Senior and Junior classes, being organized for that purpose into three companies. There were a few squad drills for the benefit of new students of the fourth class, particular attention being paid to the manual of arms. The remainder of the time was devoted to company drill. There were during this term twenty-eight exercises, the last one being on the 6th of November, when bad weather set in. During the spring term there were about an equal number of exercises, mostly in battalion drill. The exercises both of the fall and spring terms averaged more than forty minutes in length.

I would respectfully call your attention to the recom-

*So ordered—Res. Dec. 29, 1874.

mendation, contained in my report for last year, that a suitable drill hall be erected as soon as possible.

Since the close of the year 150 breech-loading Cadet Rifle Muskets, with belts and accontrements complete, and also a section of light twelve pounder field pieces, with carriages and caissons complete, have been procured by the Regents from the U. S. War Department for use in my department.

The course of theoretical instruction in Military Science, recommended in my report for last year, has been adopted, and several students have signified to me their desire to complete such a course.

Very respectfully,
E. L. HUGGINS,
First Lieut. 2nd Artillery, U. S. A.,
Prof. Military Science and Tactics.

PROFESSOR WINCHELL'S REPORT.

To the President of the University:

SIR: At the beginning of the winter term, Jan. 6, 1874, I took the Third class in Physical Geography, so-called. During the fall term previous they had been taught by Mr. D. P. Strange, and had been taken over *Cornell's Physical Geography*, and introduced to *Loomis' Treatise on Meteorology*. They were continued the first half of the winter term on the subject of Meteorology. The class numbered twenty-nine. With the exception of a few paragraphs involving mathematics higher than the class had yet mastered, the treatise of Loomis proved very useful and highly interesting.

The Junior class began the study of Geology Jan. 6, 1874, and pursued it, according to the programme of studies then in force, the full time allowed—one term. In that short time but a very hasty glance at the science can be accomplished. They devoted it to Historical Geology. The class was taught by a series of familiar lectures and conversations, with occasional blackboard diagrams and formal recitations, using *Dana's Manual*. This class contained four members.

The Third class began Botany about the middle of the winter term. They were kept on the elements through the remainder of that term, and till flowers appeared in the

spring. With the appearance of flowers, they began the analysis and determination of species. They easily determined the maximum required for each student independently, exclusive of those analyzed in class, numbering forty species, by the end of the spring term, some of them recording seventy-five or more species. The class used *Prof. Asa Gray's Lessons* and *Morgan's Student's Plant Record*. There were thirty-one students in Botany in the winter term, and nineteen in the spring term.

On the elements of Zoology the First Class, numbering twenty-three, spent the winter term, using *Chambers' Elements of Zoology*. The time allowed was too short and the results attained correspondingly meagre. I am fully convinced, that unless greater facilities and more time be allowed in the prosecution of this, and other natural sciences, they had better not be attempted. Under the new scheme of studies, Zoology is hence reduced to an optional study, and continued so through two terms. Very much of the interest in the study of Zoology is dependent on the means of illustration in the hands of the instructor. Of this we have almost nothing. I wish again to urge the necessity of charts and diagrams for this purpose. There should also be specimens of natural objects accessible to both the instructor and the pupil. It is here that the equipment of our museum is to serve the University.

According to the new programme of studies, Dynamical Geology is required of all courses in the Third Class during the second term. Lithological Geology, or Mineralogy, is required of the Scientific Juniors in the second term, and is optional with the Classical and Modern Courses. Historical Geology is required of the Scientific Juniors in the third term, and is optional with the Classical and Modern Courses. This is a great improvement on the old programme, in as much as it allows a possibility of three terms in Geology against one term before, but it still presents an incongruity in requiring all courses to begin the study in the Third Class but does not require them to complete it.

In Zoology, nothing is required in the College of Science, Literature and the Arts, but it is made optional in the Collegiate Department, two terms, viz.: For the Second Class, Scientific and Modern Courses in the second term; and for the First Class, all courses in the third term. It is also a required study one term in the Elementary Course in Agriculture, in the Second Class, second term, and optional for the First Class, third term.

Botany is now a required study of the Classical and Scientific Courses, and optional with the Modern of the Third Class, in the third term. In the College of Agriculture the study of *Systematic Botany* is required of the Juniors in the third term, and in the Elementary Course, the Third Class pursue Botany in the third term.

Physical Geography is restricted to the Fourth Class, where the Scientific Course requires it in the first term of the year.

With this improved arrangement of the studies of the "Department of Natural Sciences," and by the aid of maps and other means of illustration, it is hoped that in the future it will be no mockery to students to invite them to the pursuit of these sciences.

Very respectfully,
A. H. WINCHELL,
Professor of Geology.

PROFESSOR RHAME'S REPORT.

To the President of the University:

SIR: I have the honor to submit the following report of the work of my department for the year ending June 18th, 1874.

The following table exhibits the classes taught and the subjects studied during the year:

FIRST TERM.

Study.	Class.	No. Students.	No. Exercises.
Physics, - - -	I.	20	65
Use of Insts. & Leveling,	Junior.	2	30
Topograph. Drawing, -	Junior.	3	35
Drawing—Plane Problems,	II.	4	65

SECOND TERM.

Mechanics, - -	Junior.	4	60
Drawing, - -	III.	39	60
Descriptive Geometry, -	I.	6	60
Drawing, - -	II.	6	60
Drawing, - -	Junior.	3	60

Triangular Surveying, -	Junior.	2	40
Henck's Field Book, -	Junior.	2	45
Drawing—Perspective, -	I.	6	45
Surveying, - -	II.	22	24

The work of locating the new buildings of the University, and of establishing the corners thereof was done by members of this department. A survey of the old building, and plans of the old and new buildings, necessary in planning the heating apparatus, were made by my students.

During the spring a very fine leveling instrument was obtained for the use of the students.

Very respectfully submitted,

M. D. RHAME,

Asst. Prof. of Civil and Mechanical Engineering.

PROFESSOR PECKHAM'S REPORT.

To the President of the University:

SIR: Last December I made a short report, noting what had been done towards establishing a laboratory for work upon the chemical problems of the Geological Survey, and also to enable a few students to commence the study of analytical chemistry. These accommodations, although but little better than none, considering the needs of the department, rendered possible the accomplishment of considerable important work upon the peats of the State and also enabled me to introduce quite a number of our students to an acquaintance with the elementary principles of analytical chemistry. During the first term these students were two Seniors, three Juniors, and two members of the first class. At the same time, I gave instruction in general chemistry to about thirty students of the second class, of whom five were young ladies. During the second term my class in applied chemistry consisted of nine members of the second class. In addition to these, I gave instruction to one of the Senior class, in Determinative Mineralogy. The third term's work embraced the Juniors of the Scientific Course, Determinative Mineralogy, and three members of the second class in Analytical Chemistry.

The class in General Chemistry made very commendable progress, the young lady members proving themselves fully the equals of the average of the young men in a branch of science in which they are not usually supposed to be greatly interested. The work in Analytical Chemistry has been prosecuted under great difficulties. The room was unsuitable and inconvenient, and the special appliances and fixtures were very inadequate; yet by cheerful co-operation and patience on the part of the students, I have been with them enabled to accomplish more than sometimes results from more generous opportunities.

Amid these difficulties our patience has been sustained by hopes of better times, when the completion of the Agricultural building and the ample accommodations projected therein shall place the department in its proper relations to the University and to the educational and other interests of the State. Those who have the work in hand are profuse in promises, but have thus far not appeared to be especially earnest in endeavors to fulfill them. The progress of the work at this time does not offer very flattering prospects that the building will be in condition for occupation at the opening of next academic year. Meantime the necessary repairs upon the old University building will have appropriated the rooms now occupied as a laboratory to other uses, thus depriving the institution of all laboratory accommodations. Such a result would place the department in a very undesirable condition, and would render the early completion of the laboratory an absolute necessity if the wants of the classes in Analytical Chemistry are to be met at all during the next academic year. These remarks apply with equal force to the chemical work on the Geological Survey, which cannot be resumed until the completion of the new building provides the necessary accommodations for accurate analytical work. They also apply to such problems in the mining and commercial interests of the State as require the aid of chemical analysis, which it is desirable should seek solution here rather than outside the commonwealth. These problems appear to be increasing in number and interest.

I believe that the work of the year on the whole has been profitable, but the measure of success attained has been largely due to the uniform earnestness and courtesy of the students themselves.

Through the generosity of the Board of Regents large additions have been ordered for our cabinets of Chemical and Physical apparatus. At this date only a few pieces

have yet reached us. About seventy new pieces of Physical apparatus have been ordered, much of it from the best manufacturers and of the most recent and improved construction. A very complete outfit of apparatus and chemicals have been ordered for the new Laboratory. The permanent fixtures and furniture for the same have been ordered from the very best sources. The arrangements for ventilation now provided, are of the most approved character, so that I hazzard nothing in the prediction that for its size our laboratory, when completed, will be equal to any in the country, and much superior to the average. With such desirable facilities as will soon be offered them, our students can have no inducement to seek instruction elsewhere.

All of which is respectfully submitted.

S. F. PECKHAM,

Asst. Prof. in charge Dept. Chemistry and Physics.

June 18th, 1874.

MR. LACY'S REPORT.

To the President of the University:

SIR: As a report of the work done the past season, I beg leave to submit the accompanying report of the Farm Superintendent, Mr. W. T. Scott.

It shows a fair amount of work performed. The experiments that have been conducted constitute a step in the right direction; but as no single set of experiments, however well conducted, can be conclusive, the results of these must be taken as hints and suggestions rather than as conclusions and established facts.

PRESENT CONDITION OF AGRICULTURAL COLLEGE.

The farm is not in the best condition for present purposes. The portion under cultivation, consisting of about twenty-five acres, in several pieces, is of a sandy nature and in low condition from continued cropping. Five to ten acres more, in small and detached pieces, are now in condition to break. The remaining portion will probably require thorough drainage before it will produce anything but marsh hay or be fit for the plow.

The barn belonging to the College is small, but in good

repair, and can be made to answer. The Agricultural College building, when completed, will be one of the best arranged, as well as one of the few in this country, built for the special use of the agricultural department.

The library contains fifty-two volumes treating of some one or more of the branches of agriculture and horticulture. Nearly one-half of these are not now standard works and will be seldom referred to. It also contains Department of Agriculture Reports and Reports of State Agricultural and Horticultural Societies, to the number of seventy-five and upwards.

GENERAL PLAN FOR CONDUCTING THE AGRICULTURAL COLLEGE.

The undersigned desires to call your attention to this plan which will be considered under the following heads:

Course of Instruction,	Farm,
Library,	Gardens, &c.,
Museum,	Labor and Practice,
Stock,	Accounts,
Experimentation,	Extra Course of Lectures.

Courses of Instruction.—Intelligent agriculture is based upon a knowledge of the natural and physical science. Therefore the student should be acquainted with these sciences, before receiving systematic and connected instruction in the art or practice of agriculture. Not that all practical instruction is to be deferred until the last term or the last year. Verbal instruction and manual practice should be provided in each operation as it occurs in the natural course of events. But the main part—the body—of practical instruction can be fully appreciated only when some knowledge of the sciences has been acquired. Therefore let languages, mathematics and natural and physical sciences come in the first years of the course and practical agriculture later. The library, museum, stock, farm and gardens, are to serve as auxiliaries to this course of instruction.

Library.—Good books record the experience of others and of the past. Hence the library should be well stocked with the best works relating to agriculture and horticulture and their different branches, and the reading room with the best papers and periodicals.

Museum.—The labor of teaching is greatly diminished and its efficiency correspondingly increased, when proper

means of illustration are at hand. Therefore the institution should have a large and select museum. It should contain samples of all the standard and new varieties of wheat, barley, oats, corn, rye, flax, beans, specimens of the grasses, and of any other vegetable products that can be preserved. It should exhibit the different hand implements used in agriculture and horticulture and models of the larger machines. Not merely the best of these, but those also that are not so good, in order that the two may be compared and their differences explained. It should also contain drawings, engravings or portraits of things that cannot be preserved, or cannot be obtained, and of such others as it may be desirable to have thus represented. With these things at the command of the instructor, twenty minutes of explanation will be better than one hour's skillful description. Moreover, no intelligent persen will be able to visit the museum without carrying away some new ideas that will be of service to him.

Stock.—The stock, like the museum, is to be kept for purposes of instruction and illustration. For in no class of farm property is improvement more needed than in live stock. Yet probably not one farmer in five knows a Devon, an Ayrshire or a Jersey, when he sees one or the circumstances and uses to which each is suited. Or, if he does know these things, it is only from heresay, and, having no stronger evidence, he takes no active interest. I would have good representatives of the Shorthorn, Ayrshire, Jersey, Gallaway and Devon breeds of cattle; Cotswold, Leicester, Merino and Southdown breeds of sheep; Berkshire, Poland China, Essex and Suffolk breeds of swine; the different breeds of poultry and two or three breeds of horses. There should be both males and females in order that the characteristics of the sexes may be shown, the principles of breeding illustrated and income derived.

Experimentation.—All concede that one duty of the agriculture college is to conduct experiments. Thus it may indicate the varieties of grain, fruit and vegetables best adapted to soil and climate, the fertilizers best adapted to the needs of crop and soil, the best modes of feeding, &c. It should test new varieties and decide the dozens of questions that occur in the experience of every farmer. The results should not be confined to official reports but should be given to the press to be scattered broadcast among the farmers.

farm is required. To carry out the details of this plan it should consist of not less than 250 acres. A certain portion should be set aside for such experiments as require but small areas, while other experiments requiring larger areas may be conducted on the portion devoted to stock. This farm should be conducted without extravagance or show. Sufficient money and labor should be expended to accomplish the purposes it is intended to serve—support of stock, experiment, instruction and illustration. The best methods of cultivation should be pursued, the best modes of feeding should be practiced, and the buildings, to consist of house and barns, should be models for their purposes.

Gardens, &c.—In the horticultural department there must be vegetables, fruit and flower gardens, plant houses, nursery, orchard and forestry. In these, varieties are to be tested and the student is to see performed and also perform with his own hands, all the operations incident to their management, such as planting, transplanting, budding, grafting, pruning, &c.

Labor and Practice.—Each student in this college should be required to perform a sufficient amount of labor to attain some degree of skill in all the operations of agriculture and horticulture. For this labor he should receive no remuneration. But when he has acquired sufficient skill, if he choose to continue the work, he should receive what his services are actually worth, and the same for work requiring no special skill. Student labor should be preferred when it can be obtained.

Accounts.—This plan contemplates a comprehensive, thorough and minute, yet simple, system of records and accounts, so that at the end of the year it will be the work of a moment only to find the conditions and the results of each experiment or set of experiments, or the expenditures and receipts of any division of the farm or gardens. The students should be thoroughly practiced in keeping these records and accounts.

Extra Course of Lectures.—I have examined and considered the plan for an extra course of lectures, projected by this institution, to extend through the winter months, the same to be open to all comers without fees or preparatory examinations, and cannot recommend it too highly. As a means of instruction it will be superior to the "institute" system and it will prove an excellent substitute for the shorter courses of study in agriculture that some institutions are offering. The young farmer who would neg-

lect to attend would not consult his best interests, and he who could derive no benefit from such attendance must be wise indeed.

PRESENT PLAN.

The plan adopted for the present is substantially the above with some omissions and modifications. The condition and size of the farm, and the want of a barn and sufficient funds, preclude the stock feature. The same causes will compel the location of gardens, nursery, orchard and experimental grounds to be made temporarily and not permanently. Neither will immediate perfection be achieved in any of these branches.

WORK FOR THE COMING SEASON.

The plans of the work for the coming season have not yet been completed. They will, however, include the following: additions to the library of agricultural and horticultural works; the collection and arrangement of a museum; sets of experiments, in continuation of those performed the past season, to ascertain the comparative yields of different varieties of wheat, barley, oats, corn, potatoes, mangolds, turnips and beans; sets of experiments to ascertain the effect of different fertilizers upon these crops; beginning of a new nursery; laying out and planting vegetable and fruit gardens and testing varieties therein; stocking the plant house; and drainage of a portion of the farm.

NEEDS.

The needs of this deparment are varied and numerous. They are mentioned here in the hope that friends will be found in all parts of the State able and willing to assist us in supplying some of them.

More land is needed to maintain the stock which the institution should have and hopes to have at no distant day. A stock barn is needed for the protection of the same. A farm house is also a pressing want. When we can furnish work on the University farm, and board and rooms in the farm house, then we may reasonably expect more students in our agricultural courses. Farm-buildings cannot, however, be properly located until it is decided in what direction addi-

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museum will be very acceptable. We would like to have there a collection of products from each county in the State, consisting of all the kinds of grain and all the varities of each kind raised there. We want specimens of manufatured articles; spades, shovels, hoes, forks, draining tools, pruning tools, garden tools, tools of domestic use, machines, models of machines and other manufactured articles. Fruit plates and portraits of thoroughbred animals, will prove very useful, and add to the attractions of the museum.

Respectfully submitted,

C. Y. Lacy.

REPORT OF WORK DONE AND IMPROVEMENTS MADE ON THE EXPERIMENTAL FARM DURING THE SEASON OF 1874.

The old Territorial road running through the farm has been vacated, the fences removed and the road bed partly seeded down to grass and partly prepared for cultivation. Fences have been placed on each side of the University Avenue at a distance of 80 feet from each other, leaving an enclosed space of twenty feet on each side for the purpose of planting trees and securing protection for the same.

Ten acres north of the avenue have been summer-fallowed and manured and prepared expressly for experimenting with the various kinds of vegetables, testing of new varieties, &c. Seventeen acres of brush land have been cleared up and two acres of the same broken and cross-plowed.

South of the avenue one-third of the meadow land has been seeded down to timothy and red-top. The upland not occupied as nursery has been plowed, cross-plowed, dragged and surface-drained. Four acres of land have been added to that before under cultivation. One hundred loads of manure have been partly spread on the surface and partly plowed under. Twenty tons compost of swamp muck with lime have been prepared for spring use. Three acres of brush land has been cleared up. About six thousand forest trees, including a variety of evergreens, have been planted for experimental purposes.

Two hundred elm trees from the forest to be planted on University avenue for shade and ornament are now on hand. Arrangements have also been perfected for a large and select assortment of vegetable and forest tree seeds for experimental purposes. The object is to determine which

kinds are most worthy of cultivation and best adapted to the soil and climate of Minnesota. It is believed that such experiments may become the means of saving much time and money, which are now wasted on inferior varieties.

The season being far advanced and no suitable preparation having been made when the writer took charge, it was deemed advisable to devote most of the season to preparation for future operations. The same circumstances render the experiments that have been conducted less satisfactory in their results than they might have been under more favorable conditions. The following are the details of the most important experiments made:

No. 1. *Oats.*

Sown May 5th, on land fall-plowed and well worn.

Variety.	Yield of 1 Square Rod.	Rate Per Acre.
Excelsior,	4 quarts.	20 bushels
Somersett,	8 quarts.	40 bushels
Houghton,	5 quarts.	25 bushels
White Schoen,	9 quarts.	45 bushels

The earliest to ripen was White Schoen; the latest, Houghton; difference 12 days.

Somersett and Houghton were imported by U. S. Department of Agriculture. The Somersett promises to be superior in every respect.

No. 2. *Wheat.*

Imported by U. S. Department of Agriculture.

Sown broadcast May 5th, 1½ bushels per acre on fall-plowed land.

Variety.	Yield of 1 Square Rod.	Rate per Acre.	Weight per Bushel.
Arnotka,	2½ quarts.	12½ bushels.	62 lbs
Oran,	1½ quarts.	7½ bushels.	52 lbs

Arnotka, bearded, very early, berry large. Oran, grain shrunken.

No. 3. Potatoes.

Soil light sandy, in poor condition.

Yield.	Quality.
Best, Early Rose,	Best, White Peachblow.
2d best, White Peachblow,	2d best, Fluke.
3rd best, Fluke,	3rd best, Early Rose.
4th best, Jackson White,	4th best, Jackson White.
5th best, Early Goodrich,	5th best, Early Goodrich.
6th best, King of the Earlies,	6th best, King of the Earlies.

No. 4. Yield of Potatoes from seed cut and whole.

Planted in drills on old land without manure.

	Yield of 1-16 acre.	Rate per acre.
Cut to two eyes,	6 bushels.	96 bushels.
Whole,	4 bushels.	64 bushels.

No. 5. Yield of Potatoes from deep and shallow planting.

Planted in drills on old ground without manure. Received ridge culture.

No. 1, dropped in drills four inches deep and covered with two-horse plow to depth of twelve inches. Ridges leveled with a harrow twenty days after planting.

No 2, dropped in drills four inches deep and covered with hoe to depth of four inches.

	Yield of 1-16 acre.	Rate per acre.
No. 1,	6 bushels.	96 bushels.
No. 2,	4½ bushels.	72 bushels.

Earliness of maturity in favor of the shallow planted-planted, eleven days.

No. 6. Fertilizers on Potatoes.

Five tons well rotted manure on ⅛ acre gave 23 bushels, or 184 bushels per acre.

One-half bushel gypsum on ⅛ acre gave 21½ bushels, or 172 bushels per acre.

Without manure ⅛ acre gave 13 bushels, or 104 bushels per acre.

No. 7. Field Corn.

Variety.	Yield of 1-16 Acre.
White Dent,	226 lbs.
Yellow Dent,	187 lbs.
King Philip (Flint)	140 lbs,
Adams Early (Dent)	160 lbs.

Adams Early matured in 85 days.
King Philip matured in 95 days.
White Dent matured in 115 days.
Yellow Dent matured in 120 days.

No. 8. Yield of Corn Planted Deep and Planted Shallow.

Four hills, with four stalks in each hill, gave:
Planted 5 inches deep, 15 ears, weighing 5 lbs. 10 oz.
Planted 2 inches deep, 17 ears, weighing 7 lbs. 15 oz.

No. 9. Sweet Potatoes.

Planted four varieties, of which three failed. The Southern Queen matured in October. The quality was good and the yield satisfactory. It is recommended to plant on sandy soil on ridges or double furrows made by turning two furrows together with a two horse plow. Cultivate the surface with an iron tooth rake. The time to plant is about May 10th. See that the plants are well hardened before transplanting.

No. 10. Watermelons.

Four varieties planted.
Mountain Sprout.—Large, good, late.
Mountain Sweet.—Medium size, very good, late.
Ice Cream,—from Department Agriculture and marked extra early, but in fact three weeks later than Phinney's Early. Small, good, late.
Phinney's Early,—from Department Agriculture, medium size, excellent flavor, very prolific, early, new.

No. 11. Muskmelons.

Skillman's Nettled,—from Department Agriculture.

Worthy a place at the head of the list. Early, large, extra good, a great bearer.

Jenny Lind.—Extra flavor, small, early, prolific.

Long Persian,—from Department of Agriculture, new, very late, good.

No. 12. *Tomatoes.*

Canada Victor,—proved the earliest. Excellent, medium size, smooth.

Trophy,—large. Showed signs of decay before fully mature, but this result might perhaps have been deferred had it been trained to trellises. For pickling, preserving and canning the pear shaped yellow tomato surpasses all the other small varieties.

No. 13. *Cabbages.*

Jersey Wakefield,—early, quality good—one of the best.

Winningstadt,—early, large, extra.

No. 14. *Garden Beets.*

Deep Blood Red,—imported from France by Department of Agriculture.

Long Blood Red, Early Bassoon and Early Blood seemed about equal in all respects and all worthy.

No. 15. *Egg Plants.*

Early Purple.—The only kind that matured. Reliable, provided the "potato bug" can be prevented from destroying the plant. Paris Green appears to destroy the plant as effectually as does the "bug."

No. 16. *Squashes.*

Summer and Winter Crookneck, Summer Bush, Turban, Boston Marrow and Hubbard, all tried and found good.

No. 17. *Field Beets.*

Seed imported from France by Department of Agriculture.

Yellow Globe Mangold yielded best.

White Silesian Green Top and Long White Mangold yielded next best. The experiment was not satisfactory because of wet soil.

No. 18. *Tree Seeds.*

Red, White and Rock Elm seeds failed to germinate when planted 1½ inches deep. When planted ½ inch deep all grew.

The greatest source of failure in growing forest trees is found in our soil. If the seed is planted deep enough to get the benefit of moisture it fails to grow. If planted the proper depth for germination the young plants dry out unless the season be unusually wet. A generous sprinkling with rain water or a light covering of decayed straw with just enough earth to cover the seed seems to insure success.

No. 19. *Cuttings.*

Experiments suggested by L. M. Ford, Esq., who kindly furnished the wood. Time of planting May 25th, at least a month too late to insure success.

Twelve white willow cuttings, eight inches long, were taken in each of the following cases.

(1.) Wood one year old, set perpendicularly seven inches in the ground and one bud above. Two failed; ten made a small growth of wood.

2. Wood two years old set perpendicularly seven inches in the ground and one inch above. One failed; eleven made a growth of wood from three to four feet long.

3. Wood two years old, set at angle of about 45 degrees, the base four inches below and the top near the surface. Entire failure.

4. Wood two years old, set four inches in the ground and four inches above the surface. One grew; eleven failed.

Similar trials with Yellow and Italian Willow cuttings gave similar results. Those with Poplar cuttings failed entirely.

No. 20, *Treatment of Seed Corn.*

For one row of corn the seed was immersed in tar water and then rolled in gypsum. The seed was 24 hours longer in germinating, but there was no difference in the yield. Birds, squirrels and insects, except the wire worm, did not touch it.

The process is as follows: Pour one-half pint Carolina tar into ten quarts boiling water and stir well. Then cool enough to barely hold the finger in for a moment, pour in the corn, stir rapidly, pour off the water, and mix the corn with gypsum to prevent the kernels sticking together. Keep moist and plant two inches deep.

No. 21. *Ripening the wood of fruit and ornamental trees.*

A series of experiments instituted for this purpose appear to indicate that banking up the earth around the trunk to a hight of 18 to 30 inches, according to size, about the first of September, will cause an early ripening of the wood and enable the tree to withstand better the sudden changes of temperature to which it is subject.

Stripping off the leaves and cutting back appear to produce in a measure the same result.

In the search in every available direction for more light on this subject have I learned with surprise that non-culture is the right thing. Being well assured that non-culture is the greatest retarding influence on successful tree culture, I earnestly contend for vigorous and healthy growth.

W. T. SCOTT,
Superintendent.

GEOLOGICAL SURVEY, REPORT OF CHEMIST.

THE UNIVERSITY OF MINNESOTA,
Minneapolis, Minn., Feb. 1, 1875.

To the President of the University of Minnesota:

SIR: As Chemist of the Geological Survey of the State, I have the honor to report that during the year ending December 31st, 1874, no progress whatever has been made in the Chemical work of the Survey.

The accommodations provided for laboratory work in the main building of the University prior to the 1st of June, 1874, were entirely inadequate for accurate analytical work. These facilities, such as they were, have not been available since the date before mentioned in consequences of alterations and repairs upon the building involving the rooms that had been devoted to laboratory uses.

In consequence of the protracted and unnecessary delay in the completion of the Agricultural Building in which the new laboratory is to be placed, the institution has been substantially without any laboratory for a year, and the date at which the new rooms can be occupied is still undecided. It is therefore impossible to state at what time this important and pressing necessity of our geological work can receive attention.

I deem it but justice to myself to say that no efforts have been spared to induce the contractors to complete and vacate the Agricultural Building. Notwithstanding they agreed to furnish the building early in the fall, it is still incomplete. The delay has been in my judgment wholly without excuse, the result of carelessness and neglect on the part of those who were responsible for the work. I can see at present but little room for hope that anything can be done before the next academic year, but assure you that no effort will be spared on my part to place this department of the Survey on a proper basis as soon as possible.

S. F. PECKHAM.

REPORT OF THE CURATOR OF THE MUSEUM.

THE UNIVERSITY OF MINNESOTA,
Minneapolis, Dec. 14, 1874.

To the President of the University:

Since the last report was made the collections of two seasons, by the Geological and Natural History Survey of the State, have accumulated. One of these seasons, that of 1874, was spent by myself in the Black Hills of Dakota. I succeeded in obtaining several boxes of minerals, and a number of skins of mammals. Collections from various parts of the State have been also increased on our hands. A moose killed in the State has been procured for the museum. A number of parties have donated specimens as usual. One keg of iron ore from Salisbury, Conn. has lately arrived. A great many applications are made by parties in other States for exchanging, sending us rare specimens for some of our duplicates which would in turn be as rare to them.

I merely mention these things to show that while there

is nothing for exhibition to the public, there is by n means a state of inactivity in the museum; and t call your attention, and thus that of the Board of Regen to the necessity of making immediate provision fc the accommodation of the museum in the Universit building. The Board of Regents are required, by the la that intrusts to them the conduct of the Geological an Natural History Survey, to keep the collections of that su vey on exhibition in rooms properly heated, free of expens to the public. The students need the instruction derivabl from a well arranged museum. The classes of which have charge are greatly in need of the materials already co lected for illustration. The good name of the University and the scientific reputation of the state, are suffering fc the want of a room in which to exhibit, and in which to cor sult these specimens.

The museum is in very much the same condition as whe I last reported. This is no doubt largely owing to that co n dition of the buildings which has greatly incommoded all d partments, but it is not entirely so. It became necessary t remove, in great haste, and in my absence, the mineral an corals that were on shelves in a small room on the secon floor to make room for changes in the building. They wer carried to the geological laboratory in the basement and have there suffered from improper storage and handling, from pilferers who during past summer seem to have had free access to the room, from dust and from breakage. The work that had been put on the collections was rendered useless, as they will all need re-labeling and cataloguing. This brings the collections, except those that have never been removed from the boxes in which they were originally packed, into the choatic state in which I found them, and in which they will have to remain till some adequate provision be made for their exhibition and preservation.

I would suggest that the whole of the "Old Chapel," now divided by the hall into two larger rooms, be set apart for the Museum, one side to be used for Geology and Mineralogy, and the other for Zoology. There is space for an elevator in the building by which heavy specimens and boxes can be got to the fourth story. The location of the Museum determines in general the location of the class-rooms of the professors who have to consult it. They should not be in different buildings unless necessary, and should be as conveniently accessible, one to the other, as possible. For the time being, while one of these rooms cannot perhaps

be spared, the other of those designated would answer for both departments of the Museum. Into these rooms would have to be put cases properly planned and constructed, with glazed doors, for the reception of specimens, for it is worse than useless to exhibit such specimens on open shelving, where the public is at liberty to enter and examine at will. Until some such provision is made our collection will be of very little use to us. Hoping that the Board of Regents will see the expediency of taking immediate action, this is

Very respectfully submitted,

N. H. WINCHELL,
Curator.



THE

GEOLOGICAL AND NATURAL HISTORY

SURVEY OF MINNESOTA.

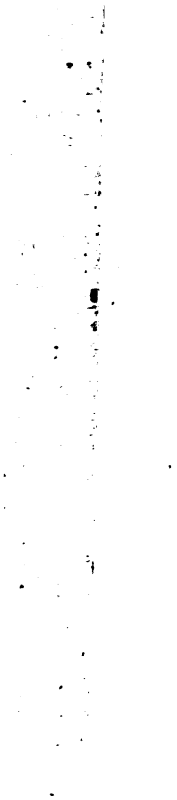
THE THIRD ANNUAL REPORT

FOR THE YEAR 1874.

BY N. H. WINCHELL, STATE GEOLOGIST.

SUBMITTED TO THE PRESIDENT OF THE UNIVERSITY DEC. 31, 1874.

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ADDRESS.

To the President of the University:

The regular work of the Geological and Natural History survey of the State was interrupted during the season of 1874. The condition of the new buildings at the University has been such that no chemical work could be satisfactorily done, and very little has been accomplished. The same cause deranges the geological laboratory and delays the unpacking and examination of specimens. Not a room has been available during the season for opening and unpacking boxes.

At the close of the spring term in the University, the Board of Regents granted the request of Col. Wm. Ludlow, U. S. T. E., and allowed the departure of the State Geologist with the expedition of General G. A. Custer to the Black Hills of Dakota. He was absent during July and August. This again broke in upon plans that had been laid for a vigorous prosecution of the field-work of the State survey. The Regents, however, rightly regarded the exploration and development of the Black Hills of Dakota as largely tributary to the State of Minnesota, while the accessions that would be made to the University Museum were likely to more than repay the expense and time required. The young State of Minnesota also may claim the honor of sending the first geologist through the unexplored interior of the Black Hills, so long involved in mysterious and legendary uncertainty. A report on the geology of the route and of the Black Hills of Dakota is herewith transmitted.* The problems that have long been debated by geologists concerning the relative ages of certain sandstones of the Lower Silurian

* By order of the Board of Regents this report has been transmitted to Col. Wm. Ludlow.

receive some light by the geological examination of the Black Hills, and some of the detailed sections of those rocks, given in the accompanying report, are exceedingly interesting. Every facility, except a sufficiency of time, was placed at my disposal by Gen. G. A. Custer, through Col. Ludlow, for the prosecution of the geological examinations. The expedition, being restricted to sixty days, and with provisions only for that length of time, was compelled to pass over the ground faster than was conducive to a full knowledge of the geology of the region traversed.

After my return from the Black Hills, delayed somewhat by sickness in my family, and by the necessary preliminary work for the accompanying report, I had only time to complete the examination of two counties. I chose Freeborn and Mower, those being next the State of Iowa and within the possible coal area of Minnesota. A local interest had been excited in Freeborn county by the developments of a shaft at Freeborn which was reported to go through several feet of good coal. This region has been thoroughly explored and the full details are contained in the accompanying report on that county. I am greatly obliged to Wm. Morin, Esq., of Albert Lea, for guidance and assistance in the survey of Freeborn county, and to Hon. A. A. Harwood, of Austin, for the same in making the survey of Mower county.

Various parties have submitted to the survey, for analysis, ores from the northern part of the State, and have applied for assistance in exploring those portions of the northern part of the State that are known to afford indications of the precious and useful metals. In some cases these samples of ores have been received and analyses have been procured, through the agency of the survey, by chemists abroad; but it has not been possible to afford any guidance to persons applying for assistance in field exploration. It is exceedingly desirable that the chemical laboratory, now nearly completed, be made available for the work of the survey, as soon as possible.

In the early part of the season, a pamphlet on *Peat for Domestic Fuel*, was prepared, at my request, by Prof. S. F. Peckham, the Chemist of the survey, for general distribution. Several hundred copies have been gratuitously distributed to those citizens of the State interested in the subject of peat fuel, and it was printed in full by the *Farmer's Union*, the principal agricultural newspaper of the State. It was hoped thereby to give the needed information concerning the nature and outward characters of peat, to the

farmers and others living in the treeless districts, that would enable them to discover and to make use of it as a common fuel where it exists, if they should feel so disposed.

During the season of 1873 but very little good peat was found in the counties of Jackson, Cottonwood and Nobles; but in the examination of Freeborn county, during the past season, inexhaustible quantities of the best qualities of fibrous peat were met with. Mower county contains very little.

Very respectfully,

N. H. WINCHELL.

THE UNIVERSITY OF MINNESOTA,
Minneapolis, Dec. 31, 1874.

REPORT ON THE GEOLOGY OF FREEBORN COUNTY.

Situation and Area.

Freeborn county borders on the State of Iowa, very near the center of the southern boundary line of nesota. It has the form of a rectangle, having a le east and west, of five government towns, and north south, a width of four, making an area of 720 square or 449,235.63 acres, after deducting the areas cover water.

Natural Drainage.

With the exception of Freeborn, Hartland, and Char townships, the surface drainage is toward the south southeast. The county embraces the head waters Shellrock and Cedar rivers of Iowa, and those of the river, which joins the Minnesota toward the north. it lies on the watershed between two great drainage s For the same reason none of its streams are large Shellrock, where it leaves the State, being its largest. streams have not much fall, but afford some water-p which has been improved in the construction of flo mills. Such are found at Albert Lea and at Twin I In these cases the body of water confined in the upper serves as the water-head and reservoir, the mills being structed near their outlets. There is also an availabl ter-power at Shellrock village, but its use would caus flooding of a large body of land adjoining the river.

Surface Features.

The surface of the county, although having no remar and sudden changes of level, yet is considerably diver as a rolling prairie, more or less covered with sparse and oak bushes. The plats of the United States surve





on file in the Register's office at Albert Lea, indicate considerably more area covered with timber, or as "oak openings," when the county was surveyed by them, than is now the case. The following minutes are based on an examination of their plats, and will give a pretty correct idea of the distribution of the oak openings and the prairie tracts throughout the county.

London. The most of this township is prairie, a belt of oak openings and timber entering it from the north, about three miles wide, in the center of the town, and extending to the center, bearing off to the SE , and terminating in sec. 24. The magnetic variation throughout the town was, when surveyed (1854) from 8° 20′ to 10° 42′, the greatest being in sec. 33 and 34.

Oakland. A little more than a half of this township consists of oak openings, an area in the eastern half only being prairie, with a small patch also in sec. 31. Two large sloughs cross the town, one through sections 30, 31 and 32, and the other through sections 4, 5, 8, 7 and 18. Magnetic variation about 9°, varying from 8° 12′ to 10° 8′, in 1854.

Moscow. Nearly the whole of this township is taken up with oak openings and marshes. Turtle creek crosses it from NW. to SE. A large portion of the northern half of the town is a floating marsh, containing a great quantity of peat. Mag. Var. from 9° 20′ to 10° 20′ in 1854.

Newry. There is a small patch of prairie in the northeast part of this town, secs. 1, 12, 13 and 24, and a small area in secs. 20 and 21. There is another in the NW. corner, embracing sections 6 and 7, and parts of 5, 8 and 18. The rest is openings and marsh, particularly of marsh in the SW. corner. Mag. Var. 8° 20′ to 9° 40′, in 1854.

Shellrock. A belt about 1½ miles wide along the west side of this town, accompanying the Shellrock river, constitutes the only openings or timbered portion, the rest being prairie. This district also comprises some marsh, viz., secs. 19 and 31. The first house in the county was built in sec. 33 in this town, in the SW. quarter. Mag. Var. 8° 45′ to 10o 15′ in 1854.

Hayward. A wide belt of prairie occupies about two-thirds of this town, running N. and S. through the center. On the west of this is a rolling tract embracing a portion of Lake Albert Lea and some tributary marshes, while on the east a large marsh covers sections 12 and 14, and portions of 13, 11, 15, 22 and 23. There is also a prairie tract in sec. 1.

Pickerel. The west half of this township is prairie, and the eastern is devoted to openings with lakes and marshes. Mag. Var. 9° 45′ to 11° 50′ in 1854.

Manchester. About one half of this town is prairie, the

remainder being oak openings. The prairie lies in the northwestern and southern portions. Small marshes occur both in the prairie and openings. Mag. Var. 10° to 12° 15′ in 1854.

Hartland. This town is almost entirely composed of prairie, the only timber being about Mule lake, and in the southern portions of secs. 34, 35 and 36. There is not much marsh in the town. Mag. Var. 9° 45′ to 12° 25′, (1854).

Mansfield. This town is nearly all prairie, a small patch of oak openings occurring in secs. 3, 10 and 15. The NW. part of the township is rolling and the SE. is level and wet with marshes. Mag. Var. 11° 30′ to 13° 40′, (1858).

Alden. This town is all prairie, with scattered small marshes. Mag. var. 11° 27′ to 13° 15′ (1854.)

Charleston. This town is all prairie, except a narrow belt of sparse timber about Freeborn lake. Long narrow marshes spread irregularly over the central and eastern portions of the town. In the SE. quarter of sec. 36 there is also a small area of sparse timber. Mag. Var. 11° 13′ to 13° (1854.)

Freeborn. In this town there is a little sparse timber about the north ends of Freeborn and Spicer lakes, and a little adjoining Spicer lake on the east. There are also some openings in sec. 26, where the arms of the marsh protect the timber from the prairie fires. The rest is of prairie with spreading marshes. Mag. var. (1854) 11° 55′ to 12° 50′.

North and west of Albert Lea is a very broken and rolling surface of sparse timber. This tract consists of bold hills and deep valleys wrought in the common drift of the country. On some of these hills are granitic boulders, but the country generally does not show many boulders. The drift is generally, in this broken tract, a gravelly clay. In some of the street-cuts for grading, a gravel is found, containing a good deal of limestone.

A great many of the marshes of the county are surrounded with tracts of oak openings, a fact which indicates that the marshes serve as barriers to the prairie fires. Such marshes are really filled with water, and quake with a heavy peat deposit on being trod on. They are very different from those of counties further west, as in Nobles county, which, in the summer, are apt to become dried, and are annually clothed with a growth of coarse grass, which feeds the fires that pass over the country in the fall. As a gene-

ral rule, but little or no grass grows on a good peat marsh.

The contour of the surface of the county is further exemplified by the following elevations obtained from lines run by railroad surveys. They were furnished by Wm. Morin, Esq., of Albert Lea:

Elevations taken from a Preliminary Survey made in July, 1870, through Freeborn county, Minn., by Wm. Morin:

Commencing on the State line (south), 930 feet east of the ¼ stake, on south side of section 32, T. 101, R. 20; thence north to Shellrock City, on sec. 6, T. 101, R. 20; thence N. 40° W. to Albert Lea, on sec. 8, T. 102, R. 21; thence N. 40° E. to Geneva, on sec. 7, T. 104, R. 20; and thence N. to the Steele county line.

	Above Ocean. Feet.
Station No. 1—At point 930 feet E. of ¼ stake, on sec. 32, T. 101, 20.	1,232
" " 100	1,241
" " 190	1,219
" " 199-10—Water in Shellrock river, east bank	1,217
" " 200-80— " " " west bank	1,217
" " 202	1,232
" " 300—Shellrock City (Town Plat)	1,241
" " 494—Summit between Shellrock and Albert Lea..	1,333
" " 654—Albert Lea (Town Plat)	1,263
Lake Albert Lea	1,221
" "1064—Summit at Clark's Grove	1,334
Geneva Lake (or Walnut Lake)	1,234
" "1330—At Steele county line, sec. 5, T. 104, 20	1,226

11 miles

Elevations obtained from O. D. Brown, Esq., Engineer on S. M. R. R.:

	Above the Ocean. Feet.
Milwaukee and St. Paul R. R.—Top of rail at Ramsey	1,233
Water in Turtle Creek—4 miles west of "	1,204
Oakland Station—6 miles " "	1,286
Big Marsh—12 miles " "	1,265
Lake Albert Lea—20 miles " "	1,221
Grade at Albert Lea depot	1,240
Jenning's Summit—5 miles west of Albert Lea	1,342
Grade at Alden Station—10½ miles west of Albert Lea	1,281
" " Wells " 20 " " "	1,171

The county thus appears to contain some of the highest land in the State. Some of the counties further west, particularly Nobles, and Mower county on the east, rise from one to two hundred feet higher. There is also a high and rolling tract in the north central portion of the State, covering Otter Tail county, which rises to about the same level, as shown by railroad profiles. The greater portion of the State, however, lies several hundred feet lower than Freeborn county.

ıroughout the county the soil depends on the nature of lrift combined with the various modifying local circum-ːes. There is nothing in the county that can properly lesignated a "*limestone soil*," or a "*sandstone soil.*" materials of which it is composed have been transported ıps several hundred miles, and are so abundantly and ɜrsally spread over the underlying rock that they receive ıfluence from it. The subsoil is a gravelly clay, and in ı of the county that also constitutes the surface soil. In ground this of course is disguised by a wash from the ɜr ground, causing sometimes a loam and sometimes a h, fine clay; the latter particularly in those tracts that ubject to inundation by standing water. On an undu-g prairie, with a close clay, or clayey subsoil, such low ɜ are apt to have a black, rich loam or clayey loam, the · being derived from the annual prairie fires that leave red grass and other vegetation to mingle with the soil. same takes place on wide tracts of flat prairie. In these ɜ may be but rarely a stone of any kind—indeed that is lly the case—but below the immediate surface, a foot or ːeen inches, a gravelly clay is always met with. This st doubtless formed the soil, the disintegrating forces of rain and wind, combined with the calcining effects of rairie fires, having reduced the stones and gravel to ɜr, leaving a finely pulverized substance for a surface In a rolling tract of country, while the low ground is filled slowly with the wash from the hills, and furnished fine surface soil, the hills are left covered with a and stony surface soil. For that reason a great many 's are sometimes seen on the tops of drift knolls. ːtreams, and about the shores of lakes, the action of er has carried away the clay of the soil and often to the original drift, letting the stones and boulders lown to the bottom of the bank, where they are often ıerous. Along streams they are sometimes again vith alluvium,—indeed are apt to be—but along the lakes they are kept near the beach line by the ac-nter ice. After a lapse of time sufficient, the banks s become rounded off, and finally turfed over or ith trees. These lakes sometimes extend their ally, but slowly become shallower.

nty is furnished with a number of very beautiful

lakes. These are generally in the midst of a rolling country, and some of their banks are high.

In the survey of the county the following species of trees and shrubs are noticed growing native:

Burr Oak. Quercus macrocarpa. *Michx.*
Red Oak. Quercus rubra. *L.* (This species is not satisfactorily identified.)
Aspen. Populus tremuloides. *Michx.*
Elm. Ulmus Americana (*Pl. Clayt.*) *Willd.*
Black Cherry. Prunus serotina. *Ehr.*
American Crab. Pyrus coronaria. *L.*
Bitternut. Carya amara. *Nutt.*
Black Walnut. Juglans nigra. *L.*
Wild Plum. Prunus Americana. *Marsh.*
White Ash. Fraxinus Americana. *L.*
Butternut. Juglans cinerea. *L.*
Hazlenut. Corylus Americana. *Walt.*
Frost Grape. Vitis cordifolia. *Michx.*
Bittersweet. Celastrus scandens. *L.*
Smooth Sumach. Rhus glabra. *L.*
Red Raspberry. Rubus strigosus. *Michx.*
Rose. Rosa blanda. *Ait.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Bass. Tilia Americana. *L.*
Prickly Ash. Zanthoxylum Americanum. *Mill.*
Cornel. (Different species.)
Willow. (Different species.)
Gooseberry (prickly). Ribes cynosbati. *L.*
Thorn. Crataegus coccinea. *L.*
Hackberry. Celtis occidentalis. *L.*
Sugar Maple. Acer saccharinum. *Wang.*
Cottonwood. Populus monilifera. *Ait.*
Soft Maple. Acer rubrum. *L.*
Cockspur Thorn. Crataegus Crus-galli. *L.*
Slippery Elm. Ulmus fulva. *Michx.*
Black Ash. Fraxinus sambucifolia. *Lam.*
High-bush Cranberry. Viburnum Opulus. *L.*
Choke Cherry. Prunus Virginiana. *L.*
Shagbark Hickory. Carya alba. *Nutt.* (On M. L. Bullis' land, in Moscow township, near the county line.—*A. A. Harwood.*)

Besides the foregoing, the following list embraces trees that are frequently seen in cultivation in Freeborn county:

Spruce.
Red Cedar. Juniperus Virginiana. *L.*
Mountain Ash. Pyrus Americana. *D. C.*
Balsam Poplar. Populus balsamifera. *L. Var.* candicans.
Lombardy Poplar. Populus dilatata. *Ait.*
Locust. Robinia Pseudacacia. *L.* [The Locust dies out in Freeborn county.]
Hackmatack. Larix Americana. *Michx.*
Arbor Vitae. Thuja occidentalis. *L.*

The Geological Structure.

There is not a natural exposure of the underlying rock in Freeborn county. Hence the details of its geological structure are wholly unknown. It is only by an examination of outcrops in Mower county and in the adjoining counties of Iowa, together with a knowledge of the general geology of that portion of the State, that anything can be known of the geology of Freeborn county. In the absence of actual outcrops of rock within the county, there are still some evidences of the character of the rock that underlies the county, in the nature and position of the drift materials. There is, besides, a shaft that has struck the Cretaceous in the northwestern portion of the county, in exploration for coal.

Although the drift is heavy it lies in such positions that it shows some changes in the surface of the bed rock. It is a principle pretty well established that any sudden great alternation in the rock from hardness to softness, as from a heavy limestone layer to a layer of erosible shales, or from shales to more enduring sandstone, each stratum having a considerable thickness, is expressed on the drift by changes from a rough and rolling, more or less stony surface to a flat and nearly smooth surface, or *vice versa*. It sometimes happens that the non-outcropping line of superposition of one important formation with another, either above or below, can be traced across a wide tract of drift covered country by following up a series of gravel knolls or ridges that accompany it, or by some similar feature of the topography. Again, the unusual frequency of any kind of rock in the drift at a certain place, especially if it be one not capable of bearing long transportation, is pretty good evidence of the proximity of the parent rock to that locality.

Applying these principles to Freeborn county, we find throughout the county a great many boulders of a hard, white, compact magnesian limestone, that have been extensively burned for quicklime. These attracted the attention of the early settlers, and before the construction of the Southern Minnesota railroad supplied all the lime used in the county. Although these boulders are capable of being transported a great distance, their great abundance points to the existence of the source of supply in the underlying bed-rock. In the drift also are frequently found pieces of lignite, or Cretaceous coal, which cannot be far transported by glacier agencies. This also indicates the existence of the Cretaceous lignites in Freeborn county. In regard to changes

in the character of the natural surface, we seen a evenly flat and prairie surface in the western tier of towns, and in the southeastern part of the county, and a hilly and gravelly tract of irregular shape in the central portion. There are two ridges or divides, formed superficially of drift, that occur in the central part of the county, one north of Albert Lea, and the other south of it, separated about eleven miles, as shown by a series of elevations from a preliminary R. R. survey by Mr. Wm. Morin, already mentioned. What may be their direction at points further removed from Albert Lea it is not possible to state with certainty, but on one side they seem to trend toward the NW. Indeed there seems to be an NW. and SE. trend to the surface features of Freeborn county generally, Such rough surfaces, and especially the ridges of drift, are more stony and gravelly than the flat portions of the county. They mark the location of great inequalities in the upper surface of the underlying rock, the exact nature of which cannot be known.

In addition to these general indications of the character of the rock of the county, the shaft sunk for coal at Freeborn, reveals the presence of the Cretaceous in that portion of the county, and examinations of the nearest exposures in the neighboring county of Iowa, disclose the Hamilton limestone of the Devonian age. This limestone is exactly like that found so abundantly in the form of boulders in Freeborn county. As the general direction of the drift forces was towards the south, and as the strike of the Hamilton in Iowa, according to Dr. C. A. White (see his map of the geology of Iowa, Final Report, 1870) is toward the N. W., there is abundant reason for concluding that that formation also extends under Freeborn county. The preliminary geological map of the State of Minnesota, published in 1872, indicates Freeborn county almost entirely underlain by the Devonian, the only exception being in the northwestern corner. How much further toward the N. W. these limestone boulders can be traced with equal abundance, the explorations of the survey have not yet revealed. The Devonian does not certainly cross the Minnesota river. Yet in McLeod county, which lies in the line of strike of the Devonian of Iowa and Freeborn county toward the N.W., on the opposite side of the Minnesota river, the same limestone boulders are very abundant, some being so large as to have been reputed rock *in situ*, and quarried as such till exhausted. The northwestern corner of Freeborn county has been regarded as underlain by a limestone of the age of the Nia-

gara, belonging to the Upper Silurian, that formation in the Northwest coming directly below the limestones of the Devonian. That may be correct; but it is certain that there is in the neighborhood of Freeborn an area of the Cretaceous, which must, in that case, overlie the Silurian limestones. This Cretaceous area is believed to extend north and south across the west end of the county, and to be roughly coincident with the flat and prairie portion in the western part of the county, in which case it also overlaps the Devonian.

Explorations for Coal.

In common with many other places in southern Minnesota, Freeborn township, in the northwestern corner of this county, has furnished, from the drift, pieces of Cretaceous lignite that resemble coal. These have, in a number of instances, incited ardent expectations of coal, and led to the outlay of money in explorations. Such pieces are taken out in digging wells. The opinion seems to grow, in a community where such fragments are found, that coal of the Carboniferous age exists in the rocks below. In sinking a drill for an artesian well, at Freeborn village, very general attention was directed to the reported occurrence of this coal in a regular bed, in connection with a "slate rock." This locality was carefully examined, and all the information was gathered bearing on the subject that could be found. The record of the first well drilled is given below, as reported by the gentleman who did the work:

1.	Soil and subsoil, clay		15 feet.
2.	Blue clay		35 feet.
3.	"Conglomerated rock," (had to drill)		2 inches.
4.	Sand with water		5 feet.
5.	Fine clay, tough, hard to drill, with gravel and limestone pebbles		60 feet.
6.	Sand with water		4 inches.
7.	"Slate rock,"		7 feet
8.	"Coal,"	Probably Cretaceous.	5 feet 4 inches.
	Total depth		122 feet

This indication of coal induced the drilling of another well, situated 100 feet distant, toward the N.E. In this the record was as as follows, given by the same authority:

1.	Soil and subsoil, clay	15 feet.
2.	Blue clay	33 feet.
3.	"Conglomerated rock"	2 inches.
4.	Sand with water, and pieces of coal	12 feet.
	Total depth	60 feet 2 inches.

the previous section. The amount of coal in the sand of No. 4 was also enough to cause it to be taken for No. 8 of the previous section. Hence the boring was stopped and having thus demonstrated the existence of a coal-bed, to the satisfaction of the proprietors, the enterprise was pushed further in the sinking of a shaft. In sinking this shaft water troubled the workmen so that at 35 feet it had to be abandoned.

Three-quarters of a mile north of these drills a shaft was sunk 57 feet, but not finding the coal as expected, according to the developments of the last section above given, the explorers stopped here. In this shaft the overseer reports the same strata passed through in the drift as met with in the first well drilled, but the so called "conglomerated rock" was met at a depth of 45 feet. The sand below the "conglomerated rock" here held no water, but was full of fine pieces of coal. Before sinking the shaft at this place a drill was made to test the strata. These being found "all right" the shaft was begun. In that drill gas was first met. It rose up in the drill hole, and being ignited it flamed up 8 or 10 feet with a roaring sound. The shaft was so near the drill hole that it drew off the gas gradually, allowing the intermixture of more air, thus preventing rapid burning. From this place the exploration was redirected to the first situation, where another shaft was begun. This was in search for the "lower rock," so called, or the "slate rock" supposed to overlie the "coal." Here they went through the same materials, shutting off the water in the five foot sand-bed, and 60 feet of fine clay, when water rose so copiously from the second sand-bed (No. 6 of the first section given) as to compel a cessation of the work. In this shaft were found small pieces of the same coal, all the way. These pieces had sharp corners and fresh surfaces. The total depth here was 106 feet, and the water seems to have been impregnated with the same gas as that which rose in the drill at the point three-fourths of a mile distant. Such water is also found in the well at the hotel in Freeborn. With sugar of lead it does not present the reactions for sulphuretted hydrogen, and the gas is presumed to be carburetted hydrogen.

This account of explorations for coal is but a repetition of what has taken place in numerous instances in Minnesota. The Cretaceous lignites have deceived a great many, and

considerable expense has been needlessly incurred in fruitless search for good coal. In the early discovery of these lignites some exploration and experimentation within the limits of the State were justifiable, but after the tests that have already been made it can pretty confidently be stated that *these lignites are at present of no known economical value.* This, not in ignorance of the fact that they will burn, or that they contain, in some proportion, all the valuable ingredients that characterize coal and carbonaceous shales, but in the light of the competing prices of other fuels, the cost of mining them, and the comparative inferiority of the lignites themselves. If they were situated in Greenland they would probably be pretty thoroughly explored, and extensively mined, and even there they would have a powerful competitor in the oil there in use.*

The Drift.

This deposit covers the entire county and conceals the rock from sight. It consists of the usual ingredients, but varies with the general character of the surface. In rolling tracts it is very stony and has much more gravel. In flat tracts it is clayey. It everywhere contains a great many boulders, and these are shown abundantly along the beaches of the numerous lakes of the county. The frequency of limestone boulders, and their significance, have already been mentioned. Thousands of bushels of lime have been made from such loose boulder masses, mainly gathered about the shores of the lakes.

In general the drift of Freeborn county consists of a glacier hardpan, or unmodified drift. Yet in some places the upper portion is of gravel and sand that show all the effects of running water in violent currents. The beds here are oblique, and subject to sudden transitions from one material to another. At Albert Lea the following section was observed. It occurs just west of the center of town. It covers eight feet perpendicular, and eight feet E. and W.

* See the second annual report, pp. 187 and 201.

1.	Earth and soil, gravelly below	20 inches.
2.	Gravel, unstratified, with considerable limestone	6 inches.
3.	Stratified gravel	18 inches.
4.	Regular strata of coarse gravel	2 feet.
5.	Unstratified	
6.	Fine sand, seen	2 feet.

In a gravel bank at Albert Lea, according to Mr. William Morin, the jawbone of a mastodon was found, a number of years ago. It was sent to St. Paul, and is supposed to be preserved.

The average thickness of the drift in Freeborn county would not vary much probably from 100 feet.

In the survey of the county considerable attention was paid to the phenomena of common wells, with a view to learn the nature and thickness of this deposit, and the following list is the result of notes made:

Wells of Freeborn County.

Good water is generally found throughout the county, in the drift, at depths less than 80 feet; but some deep wells that occur within the Cretaceous belt, in the western part of the county, are spoiled by carburetted hydrogen. This must rise from carbonaceous shales in the Cretaceous, and indicates the extent of that formation. Much of the information contained in the following tabulated list of wells was obtained of W. A. Higgins, well borer, of Albert Lea:

Owner's Name.	Location.	Depth. Feet.	Kind of Water.	Remarks.
W. P. Sargent. ...	Sec. 29, Albert Lea.	28	Good.	One-half bus. of coal at 26 feet.
Geo. Stevens.....	Freeborn.	47	Carburetted	Pieces of coal in the blue clay,
T. A. Southwick...	"	46	Soft.	44 ft. of water. [26 ft. water.
Ezra Stearns.	½ m. w. of Freeb'n.	30	Good.	Found pieces of coal.
Ezra Stearns.....	" "	42	"	" " "
James Hanson. ...	1 m. nw. of Freeb'n.	50	Carburetted	" " "
F. D. Drake... ...	Sec. 13, Freeborn.	90	"	Water stands 5 ft. from the tp.
O. U. Wescott.. ..	Byron, Waseca.	94	Soft.	[and gravel.
L. C. Taylor.....	6 ms. nw. Freeborn.	96	Good.	Artesian: at first br'ging stones
Geo. Snyder, Jr....	2 ms. nw. Freeborn.	61	Carburetted	
A. M. Trigg	Alden.	37	"	Found pieces of coal in clay.
H. M. Foot.....	"	50	Good.	" " "
John Melender. ..	"	50	"	" " "
L. C. Taylor.....	6 ms. nw. Freeb'n.	96	Carburetted	Artesian,
Wm. Comstock....	3 ms. ne. Alden.	48	"	Nearly artesian.
Chas. Ayers.....	Nw. cor. Freeb'n.	125		Bore for coal.
John Ayers.....	Trenton.	142		" " lost tools.
T. A. Southwick...	Freeborn.	35	Carburetted	Blue clay—water in sand and
J. F. Jones.....	Geneva	20	Good.	Water in quicksand. [gravel.
Nelson Kengsley..	"	12	Soft.	Water in quicksand.
John Farrell.....	"	12	"	" "
A. Chamberlain....	"	12	"	" "
D. G. Parker	Albert Lea.	79	Good.	Struck gravel below the blue
Dr. C. W. Ballard..	"	38	"	In gravel. [clay.
James Barker.....	"	52	"	Small bed of gravel in blue clay.
C. W. Levins.....	"	25	"	In gravel.
H. Rowell.....	"	72	"	In gravel below the blue clay.
W. W. Cargill.....	"	85	Not good.	St'k bl'k clay, no sticks nor grit
Chas. Ostrom.....	"	30	Good.	In very fine blue sandy clay.
Lewis Gaul.....	"	28	"	"Yellow clay" all the way.
H. Rowell.....	"	72	"	Yel. and blue clay, then gravel.
Col. S. A. Hatch...	Sec. 4, Albert Lea.	42	"	Gravel and sand, water in q'ck-
Ole Knutson.....	Albert Lea.	34	"	" " " [sand.
W. W. Cargill.....	Sec. 28, Albert Lea.	28	"	Water in gravel. [on rock.
Geo. Topon.....	Sec. 29, "	65	No water.	Gravelly clay, fine sandy clay,
And. Palmer.....	" "	28	Good.	Water in green sand.
Dr. A C. Wedge...	Sec. 8, "	28	"	" "
W. C. Lincoln.. ..	Albert Lea.	32	"	Gravel and sand, then q'ksand.
Frank Hall.....	"	65	"	" " "
Town well.....	Alden.	44	"	In gravel.
A. W. Johnson	Albert Lea.	80	Not good.	Drift clay, water in gravel.
Rev. G.W. Prescott		80	"	"Tastes like kerosene."
Town well.....	Twin Lake	75	"	Clay only.
	Alden.	40	"	
A. Palmer, Jr	Sec. 29, Albert Lea.	30	"	Lump of coal at 27 feet.

In some wells at Albert Lea a muck is struck, and such wells afford a water that is unfit for use. This muck is reported to contain sticks, and is about 38 or 40 feet below the surface. It may indicate a former bed of the river, or an interglacial marsh, as Mr. James Geikie has explained in Scotland. (See "The Great Ice-Age.") It is by some called *slush*, and seems not to uniformly hold sticks and leaves, but to be rather a fine sand of a dark color. The well-diggers call it quicksand. This indicates that it is either a bed of Cretaceous black clay, arenaceous, or Cretaceous debris. Dr. Wedge, of Albert Lea, thinks the site of the city was once covered by a lake, and that this *slush* was its sediment; and that the overlying gravel, which is about 38 feet thick, has since been thrown on to it by a later force, perhaps by currents. There is no doubt that the overlying

gravel was thus deposited, those currents being derived from the ice of a retiring glacier.

Wells at Geneva are generally not over 20 feet in depth. They also pass through a gravel that overlies a quicksand. This village is situated with reference to Geneva lake as Albert Lea is with reference to Albert Lea lake, both being at the northern extremities of those lakes. The phenomena of wells at the two places are noticeably similar, and in the same way different from the usual phenomena of wells throughout the county.

At Albert Lea.

Gravel, about 30 feet.
Quicksand, with water, sometimes black and mucky.

At Geneva.

Gravel, 12 to 15 feet.
Quicksand with water.

It would seem that the history of the drift at Albert Lea was repeated at Geneva. These villages being both situated at the northern end of lake basins, are probably located where preglacial lakes existed. On all sides, both about Albert Lea and Geneva, the usual drift clay, hard and blue, is met in wells, and has a thickness of about 100 feet.

Material Resources.

In addition to the soil, Freeborn county has very little to depend on as a source of material prosperity. As already stated, there is not a single exposure of the bed-rock in the county. All building stone and quicklime have to be imported. The former comes by the Southern Minnesota R. R. from Lanesboro and Fountain, in Fillmore county, though it is very likely that the Shakopee stone from Mankato will also soon be introduced. The latter comes from Iowa, largely, (Mason City and Mitchell), and from the kilns at Mankato and Shakopee. Some building stone is also introduced into the eastern part of the county from the Cretaceous quarries at Austin.

Lime.—At Twin Lake three or four thousand bushels of lime have been burned by Mr. Cartor from boulders picked up round the lake shores. This lime sold for 75 cents per bushel. It was a very fine lime, and purely white. The construction

of the railroad put a stop to his profits, as the Shakopee lime could then be introduced and sold cheaper. The boulders burned were almost entirely of the same kind as those that are so numerous in McLeod county. They are fine, close-grained, nearly white, on old weathered surfaces, and of a dirty cream color on the fractured surfaces. They very rarely show a little granular or rougher texture, like a magnesian limestone, though this grain is intermixed with the closer grain. They hold but few fossils. There are a few impressions of shells, and by some effort a globular mass of a coarse Favositoid coral was obtained.

Besides the above, which are distinguished as "white limestone," there are also a few bluish-green limestone boulders. One of these, which now lies near Twin Lake, is about 7 feet long, by 5 or 6 feet broad, its thickness being at least 2½ feet. It has been blasted into smaller pieces for making quicklime, but nearly all of it yet lies in its old bed, the fragments being too large to be moved. This stone is also very close-grained. It is heavier than the other and more evidently crystalline. It holds small particles of pyrites. It is not porous, nor apparently bedded. On its outer surface it looks like a weathered diorite, and it would be taken, at a glance, for a boulder of that kind. It is said to make a very fine lime. Several hundred bushels of lime were formerly burned at Geneva.

Brick.—At Albert Lea the following persoas make brick: George Broughton, Wm. Cook, (G. C. Dillingham,) Hubbell Manly, (one and a half miles N. of Albert Lea; has made none in four years.) These all make what is known as "slop brick," i. e., they handle and dry them after mixing in water, without the use of sand. The latter method (with sand) is much quicker and pleasanter, but in the use of the brick there is not much choice between the methods. At Boughton's the brick are red. The clay used, which is about five feet below the surface, is fine and of a yellowish ashy color. It is underlain by gravel. The clay itself locally passes into a sand that looks like "the bluff." At other places it is a common, fine clay-loam, with a few gravel-stones. There is but little deleterious to the brick in the clay, although some of the brick are, on fractured surfaces, somewhat spotted with poor mixing, and with masses of what appears like concretions. The clay itself is apparently massive, but it is really indistinctly bedded, rarely showing a horizontal or oblique, thin layer of yellow sand. Mr. Boughton sells brick at ten or twelve dollars per thousand.

His yard has only been running the past summer, but has turned out 200,000. They have been used in Albert Lea, and by the farmers around. Oak wood costs from five to six dollars per cord.

The yard of Mr. Cook also furnishes red brick. He uses the same stratum of fine clay overlain by the same yellowish sandy clay or loam. The clay here shows to better advantage and is plainly bedded. It contains sticks, the largest observed being a litttle over half an inch in diameter. These sticks are plainly endogenous in cellular structure, but have a bark. They are not oxydized so as to be brittle, but are flexible still, with small branches like rootlets hanging to them. It is uncertain whether they belong to the deposit, or are the roots of vegetation that grew on the surface since the drift. There are no boulders of any size in the drift just here; but a few granitoid gravel-stones. The aspect generally indicates that this clay has a local character largely, but no outcropping beds can be found in the neighborhood. Mr. Cook has made this year (1874) 250,000 brick. The yard has been running five years. Brick here sell for $1.30 per hundred as they come from the kiln, or $10.25 per thousand. Hard brick from the arch sell at $1.50 per hundred. The brick here seem to show a little more lime, but they are well made and well burned.

Brick was formerly made at Geneva, and at a point about 2½ miles east of that place. At Geneva the clay was taken from the bank of Allen creek, about 18 inches below the surface. It was a drift clay, with small pebbles. That used 2½ miles east of Geneva was of the same kind. In both places sand had to be mixed with the clay. About Geneva sand is abundant, taken from the gravel and sand knolls, and from the banks of the creek.

Peat.—In Freeborn county there is an abundance of peat. The most of the marshes, of which some are large, are peat-bearing. In this respect the county differs very remarkably from those in the western portion of the same tier of counties which were specially examined for peat, in the season of 1873, and which, being entirely destitute of native trees, are most in need of peat for domestic fuel.

The peat of the county is generally formed entirely of herbaceous plants, though the marshes are often in the midst of oak-openings. The peat-moss constitutes by far the larger portion. There is no observed difference in peat-producing qualities between the marshes of the prairie districts and those of the more rolling woodland tracts of the county.

At Alden village, in the midst of the open prairie, the peat of a large marsh rose to the surface and floated, when, for certain purposes, the marsh was flooded. The water now stands ten feet deep below the floating peat, which is about three feet thick.

At Freeborn peat is now being taken out on John Scovill's land. Here it is eight feet thick, two rods from the edge, and it is probably much thicker toward the center of the marsh. That below the surface of the water now standing in the drain is too pulpy to shovel out; and after being dipped out and dried on boards, it is cut into blocks and hauled to town. That above the water is more fibrous, and can be taken out with a spade in convenient blocks. Yet the level of the water varies, and that datum is not constant. It appears as if there were here a stratum of more fibrous peat that separates from the lower, about 20 inches thick, and floats above it at certain times. In the peat at this place a sound Elk horn was taken out at the depth of 6 feet.

There is a large peat marsh in sec. 11, Hayward, owned by non-residents.

REPORT ON THE GEOLOGY OF MOWER COUNTY.

Situation and Area.

This county borders on the State of Iowa. It is bound west by Freeborn county, north by Dodge and Olmst and east by Fillmore. It has Mitchell county on the sou in Iowa. Its shape is very nearly that of a rectangle, towns east and west, and 4 towns north and south), but lacks the northern line of sections in the northeast, acro two towns. These sections were set off to Olmsted cou when Austin was made the county seat. It has, therefo about 708 square miles, or more exactly, 455,204.81 acr according to the records of the State land office.

Natural Drainage.

The Cedar river crosses this county from north to sou through the western line of towns, its point of exit bei exactly south from its point of entrance. Its chief tribut ries from the east are Dobbin's creek, Rose creek, Ot creek and Robert's creek. From the west it receives C chard creek and Turtle creek. Thus the whole of the we ern half of the county is drained into the Mississip through Iowa. The southeastern portion, also, is drain toward the south, through the sources of the Little Ced the Wapsipinicon and the Upper Iowa rivers. The nort eastern portion of the county is drained by the head wate of the Root river toward the north and east. This ri flows eastward through Fillmore and Houston counties, i the Mississippi near La Crosse. The divide between stream running north and those running south crosses Mow county from SE. to NW. nearly through the center, a

includes some of the highest land in that portion of the State The highest point in the county, on the Southern Minne sota R. R., is in Sec. 13, T. 103, R. 16 W., and that i 738 feet above Mississippi at Grand Crossing, or 1352 fee above tide water.

These streams are all small, and some of them becom nearly dry during the summer. Some of them furnis water power at a number of places. This has been im proved on the Upper Iowa at Le Roy, and on the Cedar a Ramsey, Austin, and at several places below Austin, in th construction of flouring mills.

Surface Features.

The county is distinctively one of prairie, yet has a con siderable timber along the streams. This is particularly th case along the Upper Iowa in the southeastern part of th county, along the eastern tributaries of the Root in Frank· ford, and along the Cedar crossing the whole width of th county. There is also an important tract of timber i Nevada township. The highest portions of the county ar entirely destitute of trees. They consist of a wide expans of undulating prairie. The southern towns of Lyle, Nevad and Adams may be characterized as flat. The same is tru of the most of the supposed Cretaceous area. The summit o the principal NW. and SE. watershed is formed by the Lowe Devonian, with the strike of which it substantially cor responds. Toward the east from this summit the valley of the streams running in that direction have been deepl cut out, yet not revealing any rock. They are wide, an their natural scenery is often very fine, as the view of th low expanse, wooded more or less, first appears before th traveler. The western portion of the county is considera bly below the central and eastern. This is owing to th valley of the Cedar, the effect of which is felt over a wid belt, in depressing the general level. The following point of elevation above the ocean are derived from the profile o the Southern Minnesota R. R. by O. D. Brown, Engineer:

Grand Meadow, (Sec. 14, T. 103, R. 15)	1325 feet.
Sec. 13, T. 103, R. 16	1402 feet.
Ramsey, (Grade of the Milwaukee & St. Paul R. R.)	1233 feet.
Hayward	1240 feet.

* In the report for 1872 this crossing is given at 593 feet above the Miss. R. at La Crosse, t datum line of the S. M. R. R. on the authority of Chief Engineer H. W. Holley. Adding 6 feet makes 1207 feet for its hight above the ocean.

The following were derived from the Milwaukee and St. Paul R. R. through ——— Angst, Chief Engineer:

Madison	1127 feet.
Ramsey	1093 feet.
Lyle	1075 feet.

The following minutes, touching the surface features, are based on an examination of the township plats of the government surveyors, on record in the land office. The county was surveyed in 1853. There is not a lake of any importance in the county, and but few marshes.

Le Roy. (101,14)—East half.

The Upper Iowa river crosses diagonally the southern portion of this town, and introduces a belt of undulating and more or less timbered land, about two miles in width. Some of the thickets are very dense, but generally the timber is scattering. The remainder of the town is prairie, with a large slough covering portions of secs. 5 and 8. There is a "second bottoms" noted in sec. 18, and John Priest's house in sec. 36. Magnetic Variation 9° 12′ to 10°.

Bennington. (102,14.)

In the center of this town is one of the sources of the Root river, a y-shaped slough, with an outlet toward the east. The whole town is prairie. Mag. Var. 8° 15′ to 12° 30′, the former in sec. 6, the latter in sec. 3.

Frankford. (103,14.)

This town is about equally divided between prairie and openings, the former being the SW. portion and the latter the NE. portion. The timber is generally small, and often scattering. There is a marsh in sec. 9, and settlement was begun in NE. corner of sec. 1. Mr. L. Patchin, of Frankford, was one of the first settlers. Mag. Var. 7° (in sec. 7) to 12° 15′ (in sec. 36.)

Racine. (104,14.)

There is a belt of openings, and undulating land along the southern line of this town, caused by the tributaries of the Root river, and other areas of sparse timber and brush in

secs. 10, 8 and 7, but the greater portion is of prairie. It contains but little marsh. Var. 6° 57′ to 11° 15′. Mr. J. McQuillan was the earliest settler in Racine. The same year Mr. L. Patchin settled at Frankford and laid out the village.

Le Roy. (101,15)—West half.

This town consists almost entirely of prairie. The Upper Iowa river in the eastern portion introduces some diversity of surface, and some timber. There is also a small area of similar land in the NW. corner of the town. The headwaters of the Wapsipinicon are in sec. 32, and drain a long, narrow marsh, that extends two miles further north. The most of this town is prairie land. Mag. Var. 8° 34′ to 9° 30′.

Clayton. (102,15.)

This is a high prairie town, the drainage from it being to the SW., SE., and NE. Mag. Var. 7° 39′ to 9° 7′.

Grand Meadow. (103,15.)

This township is all prairie. There is a slough with some standing water in secs. 17 and 20. Several of the high tributaries of Root river drain the eastern portion, introducing but little diversity of surface. Mag. Var. 7° 35. to 8° 25′.

Pleasant Valley. (104,15.)

Except very small areas in the NE. and NW. corners of this town, it is entirely taken up with excellent prairie land. Those exceptions are small tracts of undulating and brushy, or sparsely timbered land, along the tributaries of the north fork of Root river. Var. 7° 50′ to 8° 55′.

Adams. (101,16.)

Through the central and northeastern portions of this town run the headwaters of one of the tributaries of the Cedar river, causing a belt of diversified country, widening to the north, and spreading into the northeastern part of the town. On the east and west of this belt is prairie land. Mag. Var. 8° 43′ to 10° 5′.

Marshall. (102,16.)

In the northwestern portion of this town Rose creek introduces the usual variety of surface attending drainage valleys. Other areas of the same are in secs. 34 and 36. The rest is prairie. Mag. Var. 7° 53′ to 9° 15′.

Dexter. (103,16.)

The southern part of this town is diversified by Rose creek, otherwise it is a prairie with drainage to the N. and W. Var. 7° 25′ to 8° 30′.

Sargent. (104,16.)

This is of prairie, except in the eastern portion, where the valley of one of the upper tributaries of Root river causes an undulating belt with some timber. This belt runs NE., and is about a mile wide. Var. 7° 47′ to 8° 55′.

Nevada. (101,17.)

This town is mainly prairie, perhaps one-fifth of the whole area, situated in the southwestern quarter, being openings, and more undulating. Var. 7° 32′ to 9° 45′.

Windom. (102,17.)

The southern and central portions of this town are prairie —a wide strip along the west side, and a narrow one along the eastern, being more wooded. Rose creek crosses it from NE. to SW. It contains no lakes nor marshes. Var. 7° 24′ to 10° 6′.

Redrock. (103,17.)

The eastern half of this town is prairie, the western half openings, with small timber and brush. Mag. Var. 7° 9′ to 8° 59′.

Waltham. (104,17.)

This town is mainly prairie, the only exception being about the streams in the SW. quarter Mag. Var. 7° 35′ to 8° 35′.

Lyle. (101,18.)

This township, being crossed by the Cedar, enjoys all the variety of soil and surface, as well as the timber which uniformly accompany the principal drainage courses. A belt of timber along the east side of the Cedar crosses the center of the town from north to south about a mile in width. The prairie on the west side runs to the very river. A wet meadow, or slough, occurs in sections 8 and 17, and another in sec. 2. Mag. Var. 6° 57′ to 9° 54′.

Austin. (102,18.)

The western half of this town is prairie reaching up to the river. The eastern half is more wooded and broken. There is also a patch of prairie in the SE. corner south of Rose creek. Dobbin and Nichols were early settlers in the SE. corner. According to Mr. Patchin, of Frankford, Leveridge, was the earliest settler at Austin. Mag. Var. 6° 57′ to 9° 42′.

Lansing. (103,18.)

There is a small area of prairie in the northern part of this town, but the most of it when surveyed was taken up with openings with scattered trees and brush. In the SW. quarter of the town is a long marsh drained into the Cedar. It is about three miles in length and a quarter of a mile wide running SE. Mag. Var. 7° 9′ to 8° 40′

Udolpho. (104,18.)

A belt of undulating, and more or less timbered, land crosses this town from N. to S. accompanying the east shore of the Cedar river. It is about two miles in width, increasing to four miles in the north. A small area of similar land is found covering portions of sections 30, 31, and 32. An important marsh also occurs in secs. 27 and 34. Var. 7° 35′ to 9° 26′.

Soil and Timber.

The soil of Mower county is everywhere dependant on the nature of the drift. The underlying rock has only affected it so far as it may have mingled with the general mass. It

is hence primarily a gravelly clay, that being the character of the subsoil throughout the county. This gravelly clay, however, is not now prominently displayed as the immediate soil of the surface. Indeed the farmer in plowing rarely penetrates to it. It lies below a rich loam usually, at depths varying from zero to two or three feet, or even more. The surface itself, which has resulted from it through the agency of the forces of the atmosphere and of vegetation, is of a dark color, and in general may be designated a clayey loam, or a sandy loam, depending on the nature and completeness of the local drainage. In low grounds this loam is thick and of a dark color. It is also apt to be more clayey in low ground than it is on the hillsides or slopes adjoining: and on high hills or steep slopes it is thin or wanting, the wash of the surface having carried it into the valleys. Along streams it often consists of an arenaceous loam, variously mingled with the detritus of the flood plain.

The soil of the county is everywhere characterized by the strength and fertility that the drift soils of the northwest are noted for. They are the most reliable soils for all the purposes of the farmer that are known. The states that are regularly and deeply buried in drift deposits are known as the best farming states of the Union. Certain rock-soils, endowed with unusual special qualities, may excel in the production of certain crops, especially in favorable seasons, but for general tillage they cannot compete with the homogeneous drift soils, through which are disseminated the good qualities of the various rocks concerned in their production, in the proportions that make stability and diversity equally certain.

In the examination of the county the native varieties of trees and shrubs were noted, and the following list comprises the species that were seen. In respect to the trees it is probably nearly complete for the county, but there are, doubtless, other species of shrubs:

Trees and Shrubs of Mower County.

Burr Oak. Quercus macrocarpa. *Michx.*
Red Oak. Quercus rubra. *L.* (Not fully identified.)
Aspen. Populus tremuloides. *Michx.*
American Elm. Ulmus Americana. (*Pl. Clayt.*) *Wild.*
Different species of Willow. *Salix.*
Hazelnut. Corylus Americana. *Walt.*
Sumac. Rhus glabra. *L.*
Ironwood. Ostrya Virginica. *Willd.*
Bass. Tilia Americana. *L.*

Elder. Sambucus Canadensis. *L.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Prickly Gooseberry. Ribes Cynosbati. *L.*
Cornel. Cornus (sp. ?)
American Crab. Pyrus coronaria. *L.*
Red Osier Dogwood. Cornus stolonifera. *Michx.*
Alder. Alnus incana. *Willd.*
Cottonwood. Populus monilifera. *Ait.*
Thornapple. Crataegus coccinea.
Wild Plum. Prunus Americana. *Marsh.*
Black Cherry. Prunus serotina. *Ehr.*
Frost Grape. Vitis cordifolia. *Michx.*
Bittersweet. Celastrus scandens. *L.*
Black Currant. Ribes floridum. *L.*
Wild Rose. Rosa blanda. *Ait.*
Cockspur Thorn. Crataegus crus-galli. *L.*
White Ash. Fraxinus Americana. *L.*
Shag-bark Hickory. Carya alba. *Nutt.*
[At Lansing, and in the valley of the Cedar, one foot in diameter.]
Sugar Maple. Acer saccharinum. *Wang.*
Bitternut. Carya amara. *Nutt.*
Butternut. Juglans cinerea. *L.*
White Pine. Pinus Strobus. *L.*
[Along the rocky banks of the streams in the eastern part of the county.]
Slippery Elm. Ulmus fulva. *Michx.*
Black Ash. Fraxinus sambucifolia. *Lam.*
High Bush Cranberry. Viburnum Opulus. *L.*
High Blackberry. Rubus villosus. *Ait.*
Cedar. Juniperus Virginiana. *L.*

The Geological Structure.

Of the older rocks the lower portion of the Devonian and the upper portion of the Silurian are found within the county dipping towards the southwest. The western portion of the county is known to be immediately underlain by the Lower Cretaceous, without ascertainable eastern limits. The accompanying geological map of the county exhibits the areas of these formations as nearly as can be judged by the data known. The rock is nearly every where hid by the drift and for that reason the actual positions of the boundaries are unknown. It is quite possible, indeed probable, that the Cretaceous area extends further east, with a broken and very tortuous eastern boundary. It occurs in counties further east. In regard to the separation between the limestones of the Lower Devonian and the Upper Silurian, none has yet been discovered. It is simply known that a vast limestone formation, the upper part of which lies under Freeborn county next on the west, extends also under Mower, and appears conspicuously along the banks of the streams in the eastern portion. No characteristic fossils have yet

been seen in it in Mower county, but those that characterize the Hamilton were seen in it near Northwood in Iowa. The limestone seen at Le Roy is lithologically different from that which occurs at Frankford and resembles the Hamilton seen at Northwood. While lithological distinctions are not reliable always, especially after long intervals, yet at present this is the only reason known, so far as Mower county is concerned for separating that at Frankford from that at Le Roy. In Ohio and Illinois there is an arenaceous formation (the Oriskany) between the Devonian limestones and the Silurian, and it distinctly marks that horizon. While in the lower Devonian some arenaceous layers have been observed in Iowa, the Oriskany has not been indentified there, and probably it cannot be depended on in Minnesota to mark the separation between the Upper Silurian and the Devonian. In the absence of good exposures of these limestones in the county, it is only possible to lay down approximately the boundary line between them, and that is all that has been attempted on the accompanying map.

The Cretaceous.

The principal exposures of the Cretaceous are found in the valley of the Cedar, at Austin, and from there to the state line. The quarry of Simon Alderson, at Austin, is in the left bank of the Cedar, and exposes about 20 feet of the bedding. Much of the stone is broken and disturbed, and lies in fine clay which seems to have been jammed into all the cracks and other openings in the rock. The beds here show sudden, broken-down places, in which this clay is deposited instead, the rock being wanting for three or four feet horizontally. The stone is much more entire, and uniform in all its characters at greater depths, some slabs five and six feet long, by three feet wide, and three or four inches thick being taken out. These have a very even, fine grain, and a handsome blue color. This stone is in its natural color, light blue, and that color shows on most of the quarried blocks about the heart of the bedding; and on deep quarrying it would doubtless show only a blue color. Yet the stone seen about the city is very generally of a buff color, to the depth of half an inch to three inches, depending on the amount of weathering and oxydation. The thinner beds are altogether changed to that color. The presence of occasional concretionary iron-and-mud-balls causes a rusty stain of a yellow color over the surface of many of the slabs.

These concretionary balls fall out, or dissolve out, when in the water, and leave cavities which become larger still. Besides these, which are not common in the compact portion of the stone, but are oftenest seen among its thin beds, there are also cavities disclosed by the fracture of the homogeneous thick beds. These are sometimes perfectly empty, but often contain loose, friable matter, easily picked out, but not differing in color or grain from the mass of the rock. At other times such cavities, revealed on the fracture of the stone are lined with a perfect coating of drusy crystals which are white, and as hard as quartz, though sometimes covered with iron-rust, so as to present a red or black exterior. The texture of the stone itself is usually close, and the grain is homogeneous. Some large slabs and blocks are sawn for bases to tombstones, and worked down to a very smooth surface. It is more safely sawn to any desired dimension than cut or broken, since it fractures treacherously; yet it is not in the least crystalline. Its aspect at a distance is that of a fine-grained sandstone; yet it contains no apparent grit. It is so soft that it can be cut without difficulty, appearing much like an unusually indurated blue shale, but it hardens in use and becomes a very enduring and useful material for building. It contains, but very sparingly a few molluscous fossils, too much absorbed to be identified, though one has the general form of a *Gryphaea*. This description of the stone applies equally well for the stone taken out at other quarries further down the valley, as mentioned below.

In the vicinity of Mr. Alderson's quarry, perhaps fifty rods distant, and about 14 feet higher, this stone was struck in making an excavation for the erection of a brewery. It here rose within two or three feet of the surface. The beds were thin, broken, and of a buff color. Enough stone was here obtained, in the excavation of a small vault, for the masonry appertaining to the brewery. The rock was here overlain by the following section of clays.

No. 1. Black sandy loam and soil..... 2 to 4 feet.
No. 2. Band of red and variegated compact clay..... 6 in. to 4 feet.
No. 3. Yellow ocherous band of clay 6 in. to 4 feet

The superposition of these bands of clay is not so regular as indicated by the foregoing section: occasionally No. 3 is broken through or is wanting, and No. 2 lies on the rock, or passes down into its crevices. Yet No. 3 is generally the first over the rock. They vary in thickness and swell out in shapeless masses of hard clay. Such hard masses are

seen sometimes to embrace bits of angular earthy rock, much like ochre, varying in color from a dark, burnt-umber color to a lighter shade, even to buff, and appearing, when of a lighter color, much like the mass of No. 3. They can be scratched easily with a knife, and however black they may be they give a red haematite streak. When they are faded the streak also fades into a brown or yellowish brown like limonite. Intermingled very irregularly with No. 2 and sometimes also with No. 3 are masses of greenish clay which has in every other respect the same outward characters as No. 2. There are here also large crystalline, detached masses of apparently a siliceous limestone which is very hard and close-grained. In some cases, however, this varies to a porous and nearly white limestone that appears to be very pure.*

At Austin angiospermous leaves were obtained from this stone in the digging of a well by Mr. L. G. Basford. After passing through soil and loam three or four feet, and clay about 20 feet, the rock was struck and penetrated by removing the upper layers, a thickness of about eight feet. Two species of fossil leaves were found in the layers thus entered. One appears like *Ficus primordialis*. Hr., as figured in "*Les Phyllites Cretacees du Nebraska par M. M. les prof. J. Capelini et O. Heer*," and the other is, according to Dr. J. S. Newberry to whom a protographic copy was submitted, probaby a species of *Sequoia*, a gymnosperm of the pine family known as "Redwood."

At the mill of J. Gregson, about two miles below Austin, a great deal of stone has formerly been taken out, but now the quarries of that neighborhood are nearly all flooded by the water of the dam. The chief quarry was just above the present site of the mill and near the dam on the left side, though just below the dam the rock shows on both sides and has also been wrought. At this point Rosenberry and Miner have a quarry on the right banks, and a perpendicular bluff of the beds occurs near the roadside, below the mill on the left bank. The exposed section at Rosenberry and Miner's is as follows, in descending order:

* In connection with this description of limestone masses, it is interesting to note the occurrence at St. Charles, Winona County, of hard siliceous limestone masses on the surface of the ground, appearing very much like those embraced in this clay.

The reader is also referred to the *Geological Report on the Exploration of the Black Hills under Gen. G. A. Custer, in* 1874 for further information on the distribution of foreign limestone masses in Dakota.

No. 1.	Black loamy soil	7 to 8 feet.
No. 2.	Loose fragments of the underlying beds and clay mixed	3 feet.
No. 3.	Heavy stone like that described at Austin, clay filling the open planes and joints	10 to 12 feet.
No. 4.	Rusty bituminous films	½ to 1 inch.
	[On the authority of the owners of this quarry to this section may be added the following:]	
No. 5.	Limestone, filled with shells, blue, contains flint, makes lime, penetrated	2 feet.

The bedding of No. 3 is here broken in a manner similar to that of Alderson's quarry at Austin. The corners and angles of the beds are replaced by clay and the color of the stone is changed from blue to buff or drab, to the depth of about two inches.

Some years ago the rock was worked by Dr. Barns, of Austin, about half a mile above Gregson's mill. This quarry is now almost entirely flooded by the dam. The abutments of the upper bridge, at Austin, came from this quarry, in part. Judge Ormanzo Allen owned a quarry still above Barns' that was also considerably flooded by the same means. The quarry most worked was just above the mill, owned by M. J. Woodson. It is now entirely under water. Stone is still taken out, however, all along, both above and below Gregson's. The beds at Gregson's show very nearly the same characters as at Austin. The descent of the stream is over about fourteen feet of rock, the layers of which are sometimes two feet or more in thickness, or massive, much like an indurated shale. In weathering, these thick beds are checked by planes running mainly horizontal, instead of perpendicular or diagonal. Although mainly horizontal these planes are apt to unite after a few feet, splitting up the heaviest beds into wedging, lenticular masses. Some parts are here plainly calcareous, affording traces of fossil remains that have the appearance of brachiopoda. These portions are porous as if by the absorption of fossils.

Mr. M. J. Woodson now works a quarry about ¼ mile above Gregson's mill, some distance from the river, pumping by windmill the water out of a slough in which the beds are exposed. A small creek passes through here, and this slough seems to be an expansion of the valley, retarding the water. The rock is here entirely below the water, and is nearly all blue, and in that respect appears well.

At the mouth of Rose creek about the same thickness of the same kind of stone can be seen in the bed and banks of the creek. A fine exposure is owned by J. D. Woodard in

the right bank of Rose creek near the crossing of the r from Austin to Officer's mill, perhaps a mile above its un with Cedar. It is again seen above Officer's on the land Col. Lewis, on the east bank.

At W. H. Officer's mill, the left bank of the river sh about 20 feet of bedding. This is one mile below R creek. South of this mill rock of the same kind is seen a number of places before reaching the State line. At t miles below Officer's it is quarried on R. B. Foster's la and on Mrs. John Niles', three-fourths of a mile below F ter's, on the west side of the river. Just below the St line is Alderson's mill, where it is again exposed. At C cer's, the water power is 8 feet. It is 13 feet at Gregs and 10 feet at Austin. Between Austin and Lyle the coun is apparently a perfectly level prairie, and is doubtless clos underlain with the same rock as at Austin.

Two miles east of Officer's mill a farmer struck the sa rock in two separate wells on his farm, in one at the de of three feet and in the other at eleven.

Dobbin's creek, which joins the Cedar at Austin from NE., furnishes a water-power of 14 feet by dam, wher mill is erected. A quarry in the left bank of this cr shows the same rock as already described at Austin in Cedar. The bluffs of the creek just below the mill are ab 30 feet, and show about 20 feet of rock. The beds are every place greatly broken, and in some cases displac The rock is parted into blocks of varying size, according the thickness of the layers, the uppermost being fin Throughout, the partings, and all the interstices are clos filled with a greenish clay, making the whole a close a almost impervious mass. It has very much the aspect the Cretaceous on the Silurian, as described at Manka (see the second annual report) except that the small cra and openings are here all densely filled with the clay. clay also very rarely has any distinct bedding, but see rather to have been jammed in to fill the vacancies. Besi the greenish clay which often varies in color to a red o buff, there is also considerable white, clean sand, lodged these cavities in the rock. This pertains to no partic horizon, and shows no definite arrangement. It is dispo everywhere, just like the clay, occurring from the top to bottom of the bluff—though perhaps more abundant n the bottom.

These two deposits—the clay and the white sand—doubtless the result of destructive forces upon other porti

of the Cretaceous. There is presumptive evidence, in their being here irregularly mingled with a series of beds that lie nearly *in situ*, that they are derived from some *overlying* members of the Cretaceous. That evidence would be more reliable if the general dip of the Cretaceous were toward the north or northwest, thus throwing the beds of the quarry deeper below the surface in those directions and rendering them less susceptible of such disruption as would expose the underlying members to the glacial forces. That is naturally the first inference on beholding the face of the bluff. On the contrary the actual dip of the Cretaceous, if it have any at all, would be in general toward the south or southwest at this place, and the lower members are thus brought nearer the surface and within the transporting agency of the glacial forces at points toward the north. Thus this clay and sand may have been brought, by the action of ice, in the glacial epoch, from the north or northwest and deposited on the top of an overlying rock, in the same manner as granitic boulders are brought from a granitic region toward the north and are spread by the agency of ice, over the Silurian or Devonian, or even over the Cretaceous, that overlie, by hundreds of feet, the granitic beds from which they are derived. This clay and sand however are so fragile that they would soon lose their identity in being carried by the mixing power of a glacier, and cannot have been far transported. Indeed the area over which the beds of the rock with which they are mingled are known to extend unbroken, without perceptible dip in any direction, is quite as great as they could be carried by glacial action and deposited in distinct and characteristic homogeneity. There is hence a strong probability that the rock from which they are derived occupies a higher geological horizon than that among the broken beds of which they appear. This white sand must be the same as that seen on the Blue Earth and its tributaries, and on the Waraju in Brown county. (see the second annual report pages 133 and 185.) It there lies on the Lower Silurian unconformably. Here it seems to be underlain by an older member of the Cretaceous—the Austin rock. This indicates the earlier submergence of this portion of the State beneath the ocean of the Cretaceous age, and the approach of the Cretaceous ocean from the east or southeast. As to the relative ages of this dislodged clay and white sand, there is no way of deciding which is the older from any certain evidences in Mower county. But in Brown county there is a bluish-green clay that overlies the white sand.

This rock is also wrought on the right bank, just above the mill, showing here also the same features.

At Sargent's Spring, SW. ¼ sec. 31, Redrock, there is apparently an exposure of this white sand below the level of the water of a little pool. This place is a local celebrity. Pure, soft water boils up over the area of about a square rod, and sometimes over double that area, and can be seen issuing from the ground, bringing with it clean, white sand. The bottom of the pool presents a beautiful appearance. The water is as clear as crystal, and the boiling points which appear by reason of the rising white sand, in the midst of the darker sediment, can be minutely inspected at a depth of five or six feet. Running a stick into the agitated sand, it soon strikes a sandrock which is doubtless the source of the boiling sand, and the same bed that furnished that at the quarry in Dobbin's creek.

On the SE. ¼ sec. 12, Windom, Mr. Thomas Smith has struck the Cretaceous in making explorations for coal. From Mr. Smith the following account of his efforts was obtained. His attention was first attracted by a "scum that stood on stagnant water" and by the "mud brought up on horses feet" in crossing the creek bottoms. Having chosen a locality along the bank of Rose creek which he judged suitably free from water, he began to drift into the bank of the creek following a bed of vegetable material that had the appearance of old peat, but which contained some coarse pieces of fibrous wood. The choice of this place was altogether accidental, the desire being to obtain a place free from water. There were no surface indications favoring coal at that point. He accidentally came upon the peat bed. At first the peat, of which Mr. Smith has preserved samples, and which consists entirely of comminuted vegetable fibre, was only half an inch in thickness. In the coarse of the drift it gradually thickened at 70 feet, to 18 inches in thickness. This drift was nearly level, inclining a little for the sake of drainage. On the top of this peat, pieces of wood which were judged to be of pine and cedar, of which also Mr. Smith has pieces preserved, were found in abundance. One large piece was two feet long and ten inches in diameter, supposed to be pine. This drift was about 50 feet below the general surface and 6 or 7 feet above low water in Rose creek. Above it was a blue clay with gravel stones. Below it was also a dark blue clay with gravel stones. This peat seems to have been in a genuine ancient peat lake, filled or partly filled, on which

floated pieces of wood from the surrounding forest. The whole was buried again by glacial deposits fifty feet thick.*

This drift having been abandoned at 80 feet, a shaft was sunk twenty rods toward the SW. to the depth of 50 feet, meeting the same peat. This shaft passed through fifteen feet of sand, ten or twelve feet of yellow clay, and about 23 feet of gravelly blue clay. Then east of the drift 40 rods a shaft was sunk on lower ground, but not on the bottoms, though somewhat within the general valley. The section here was, as given by Mr. Smith:

No. 1.	Soil and gravel	5 feet.
No. 2.	Gravelly blue clay	4 or 5 feet.
No. 3.	Gravelly yellow clay	14 feet.
No. 4.	Blue clay, not gravelly	9 feet.
No. 5.	Brown, waxy clay, fine	6 inches.
No. 6.	Rock with water, (Mr. Smith says a specimen of "blue slate" came from this level)	3 feet.
No. 7.	A soft rock which furnished fine drillings that were taken for "coal"	4 feet.

In this drill, the first 22 feet of which were a shaft, Mr. Smith next came upon a very hard rock, and as all his work was done by hand he did not succeed in entering this stratum, nor in getting a specimen.

At this point Mr. Smith made efforts to get help from the county commissioners but they declined. He next sank a shaft forty feet in depth, about twenty feet from the last, meeting about the same materials, except that here there was no "blue clay not gravelly," and no "fine, waxy, brown clay." He struck the rock at the same depth. The bottom of the "gravelly yellow clay" here was hard "like brick," cemented by deposits from the water which came in from below immediately after penetrating through it. This was a shaft throughout. Here the work stopped.

On visiting the last shaft which was all dug, the rock struck is seen in fragments lying about. It is a fine sandstone now rusty-brown with iron, but which on being taken out was at first of a bluish gray color, like the deeply cut Austin stone. This is somewhat coarser than that and more loosely grained, but in every other respect appears to be the same rock.

* This peat was again struck in a shaft twenty rods further SW. from the drift, and was there about a foot thick, and about the same depth below the surface. It was met in wells two and a half or three miles northwest, at thirty-five feet.

The Devonian.

The most westerly outcrop of these limestones within the county, is that on Mr. Andrew Robertson's land, sec. 26, Windom. The rock here seen is course and porous, but rather firm, and very slightly exposed. It occurs in the valley of a small tributary of Rose Creek.

The quarries at Le Roy are owned by Joseph Brevier, Judson A. Palmer, Stephen Drowne, and the heirs of L. Johnson.

The quarry owned by the heirs of Johnson is about forty rods from the State line, in sec. 35, Le Roy. It is in a lightly timbered tract of country, accompanying the upper Iowa river, and about ten rods south of the river. The beds rise to within a foot or two of the surface, on the angle of the river bluff, though the bluffs of the river are not conspicuous, the depth of the valley being only about twelve or fifteen feet below the general level, and broad and basin-like. The foreign drift about is light, but some large boulders are scattered about. This stone is light colored (nearly white) hard and fine, exactly like the Devonian seen near Northwood, in Iowa, though in heavier beds than that. It would make a beautiful white marble. It is uniform in grain and texture, and not in the least porous. With the exception of one or two layers of an inch or two of green clay, the beds are all of this limestone, exposed twelve feet.

At Palmer's quarry the rock is overlain by six inches of soil, though a hundred rods from the river. These beds are all badly weathered so far as opened, and of the same general character as at Johnson's. No drift. Exposed three feet.

Mr. Palmer's other quarry is in the river bluff, and easy of access. The stone is the same as that already described, and has been burned near the quarry for quicklime. It forms a bluff, exposing about twenty feet.

Brevier's quarries, of which two are opened, are in the left bank of the Upper Iowa river, and show about the same beds as seen in the other quarries.

Drowne's quarry is also in the bank of the river, but shows only about six feet, though there is every opportunity for opening the beds to a greater depth. There is here a much more argillaceous and fissile bed than any seen in the other quarries. It is about eighteen inches thick. This layer, coming about midway in the quarried beds facilitates the working of the quarry, but is itself of no value. In

the debris thrown out, probably from this layer, a globular mass of *Cœnostroma* was obtained, which, taken with the lithological resemblance of the rock to that containing Hamilton fossils at Northwood, in Iowa, near the Minnesota State line, satisfactorily establishes the Devonian age of the whole of the rock at Le Roy.

Section 16, Le Roy, Mrs. Alice Plummer owns a newly opened quarry near the river.

There is an exposure of the limestone in the valley of the upper Iowa, near the west line of the SE. ¼ of NW. ¼ of sec. 29, Le Roy. There is here a boiling spring coming out of the rock in the bed of the creek. The rock is also exposed just over the State line, in Iowa, on the Little Cedar, and more particularly at Staceyville, two miles south of the line.

The Silurian.

As already stated, the rock at Frankford is classed as Silurian on lithological evidence only. The quarries here, beginning with the highest up the creek (known as Deer Creek) are owned in the following order: A. Bush has a quarry about four miles above Frankford; G. Fryer has a good quarry; E. W. Elder burns and sells lime at Frankford; L. Patchin's quarry is situated in the brow of a small valley tributary to Deer Creek, and consists of beds that are much shattered and weathered, so as to afford irregular and small pieces, considerably used for lime. Exposed about seven feet. These beds overlie or are very near the tops of the beds in the next—that of Mr. J. Hawkins. This is in the bluff of Deer Creek, and supplied the heavy stone placed in the abutments of the highway bridge at Frankford. The exposure here is about twenty feet. The layers are three feet and more in thickness, and project over the water. This is a characteristic exposure. The rock is different from that at Le Roy. It is of about the same color, somewhat darker, vesicular and porous. It is firm, has abundant calcite, and some chert. While it is plainly fossiliferous, no fossils demonstrating its age are obtainable. J. C. Easton also owns a quarry at Frankford, back from the creek, on the open prairie. Other outcrops occur favorable for quarrying. In the scarcity of fuel, but little lime is made at Frankford. Much more is burnt at Spring Valley.

A stone quarry is opened two miles northwest of Grand Meadow, on Bear Creek, owned by Mr. Coin. Another is 2½ miles east of Coin's, owned by Mr. I. O. Huffdaw.

The Drift.

In Mower county no diminution of the drift was noticed. It consists of the usual hard-pan clay. This clay shows a light color for the first 10 or 15 feet, and below that depth it is apt to be blue. Gravelstones and boulders are disseminated through it. Some of the boulders are very large and consist of granite. Some very large granite boulders occur near Rose Creek village, lying on the surface, and some are near Adams. There are some also in the valley between Adams and Le Roy. Near Mr. Alderson's quarry at Austin a granite boulder has been blasted and broken for building stone. It is at least 16 feet long by 12 feet wide. Its depth is unseen. Others were seen equally large in various parts of the county.

The most interesting development in respect to the drift in Mower county consists in the discovery of an ancient bed of peat by Mr. Smith in Windom. The reader is referred to the account of his operations for coal, already given, for the particulars of this discovery. This bed of peat seems to be of considerable extent, superficially. A similar deposit is struck in wells at Le Roy. Mr. J. D. Wilsey, on sec. 31, met it at 20 feet. Mr. Porter, who dug his well, describes the deposit there as largely made up of distinct woody fiber, among which he thought he recognized hemlock bark. Several other instances of striking this buried vegetation are reported in the neighborhood of Le Roy. The clay overlying the peat bed is described as a gravelly yellow clay.

In the State of Iowa an ancient peat has also been met with at a number of places. Dr. White describes it at Davenport, at Iowa city, and in Adair county (*Geology of Iowa*, 1870, Vol. 1, p. 119) and refers its origin there to marshes that accompanied the valleys of the rivers near which the peats occur, when those rivers spread wider, and flowed at higher levels. But in Mower county the peaty deposit is not confined to the valleys of streams, nor to the proximity of streams. Mower county is on one of the highest divides in the State of Minnesota, and from it flow the sources of streams toward the north, south, and east. Those streams are small and never could have flooded the extent of country in which this peat is found. The positive information now at hand in reference to this peat deposit in Mower county, does not warrant confident assertions as to its origin. From all accounts it appears to be embraced

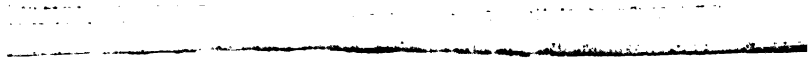
between glacial deposits of gravelly clay, and it seems to mark a period of interglacial conditions where coniferous trees and peat mosses spread over the country. Peat mosses are not necessarily restricted to low, wet places. If the atmosphere be moist they will flourish on any surface, and an accumulation of good peat may take place on a bare, rocky mountain-side. There are extensive marshes now existing in northern Minnesota, mainly covered with ericaceous plants, with some cedars and tamaracks, that are forming immense peat deposits. With an increase in the amount of moisture of the air such peaty accumulations would spread over much higher levels. A return of glacial conditions would bury such marshes below the deposits that are known as drift.

At Le Roy Mr. Porter seems also to have discovered, just in the border of the village, an old valley, now filled with sand. His cistern was dug in the solid rock, which was met at seven feet. A well was bored fifteen feet distant toward the river, to the depth of 32 feet, in sand, without meeting any rock. Between this well and the river other wells have struck the rock at several places, and usually at about twelve feet. On the prairie throughout the county wells get water generally within thirty feet.

Material Resources.

With the exception of the central high prairie portion of Mower county, it is tolerably well supplied with wood for common fuel. On the prairies referred to wood is costly. That portion of the county is thinly settled with farmers. Along the valleys of the streams in the eastern and western portions of the county, the first settlements took place, and in those valleys are found the most of the population at this time. The principal natural wealth of the county lies in its soil and its agricultural adaptations. The people are generally farmers. The growth of the county in all respects will be primarily dependent on, and co-ordinate with the settlement of the farming lands, and their profitable tillage. There is some water power in the county, as at Austin, and below Austin to the county line, and at Le Roy and Ramsey, and it is well improved in the erection of flouring mills. Mower county contains no peat, and cannot hope for coal. The rocks that underlie the county cannot be depended on for producing anything but building stone and quicklime. Of the former, some of the limestone would produce a good

marble, if properly handled. That is the case particularly at Le Roy. For making quick-lime there is ample opportunity. The only difficulty will be a competition with other localities from which transportation is light, that possess cheaper fuel for calcination. Brick can be made at almost any place in the county. Three miles northeast of Lansing Mr. John Just is engaged in brick-making. At Austin Mr. A. H. Alsip now manufactures brick. Formerly they were also made by Smith, Tuttle and Tracy, and by Horace Webb. Mr. Alsip lays his own brick in the wall for $12.50 and $13.00 per thousand, furnishing everything. He sells for $12 and $15 per thousand. He makes a sand-mold brick, free from lime, but rather soft. He burns the common surface, taking off about three inches, so as to remove the grass-roots. During the year he has made about 550,000, oak wood costing about $6.50 per cord. At Austin a light-colored brick from Watertown, Wisconsin, is somewhat used. Brick from Chaska, Carver county, are delivered on the cars for $8, costing $13 at Austin. The lime used at Austin is mostly from Mitchell, Iowa. At Le Roy not many brick have been made. The Caswell House and the school house at that place are built of brick made at Le Roy. The quality of the Le Roy brick is as good as any seen at Austin. About three miles above Frankford the Shaw Brothers have begun the manufacture of a fine light-colored brick, though some are also red. This yard is said to turn out some of the best brick made in the county. To those interested in burning lime in the county the following statements obtained from Schuyler and Hulme, of Mitchell, Iowa, extensive lime-burners, will be of value. They have one draw kiln, which is in constant operation, of Page's Patent, from Rochester, New York. It affords 200 bushels of quick-lime every 24 hours. It requires 48 hours to take a piece of the rock through the kiln. Every 24 hours four cords of wood are consumed, at a cost of four dollars per cord. One cord of stone is calculated to make 100 bushels of lime, at 80 pounds per bushel, which sells at the kiln at 35 cents per bushel, average price. Coarse lime will fall six pound short by measure, but if the fine lime be put in it will hold out weight, previous to being air-slacked. Air-slacked lime averages about 55 pounds per bushel. To run this kiln requires seven men, including those who take out the stone, or five men and one team.



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